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AIR WARFARE

An International Encyclopedia

WALTER J. BOYNE EDITOR

AIR WARFARE

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EDITED BY

Walter J. Boyne

ASSOCIATE EDITORS

Michael Fopp

Fred Johnsen

Stéphane Nicolaou

George M. Watson Jr.

FOREWORD BY

Michael J. Dugan

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Ritchie, Richard S. "Steve" (1942–)
Rocket Research in Germany (World War II)
Rockwell International
ROLLING THUNDER (1965–1968)
Rosendahl, Charles E. (1892–1977)
Royal Aircraft Factory
Royal Australian Air Force (RAAF)
Royal Bulgarian Air Force
Royal Flying Corps (RFC)/Royal Naval Air Service (RNAS)/Royal Air Force (RAF)
Royal Norwegian Air Force (RNAF)
Royal Thai Air Force (RTAF)
Royal Yugoslav Air Force (RYAF)
Rudel, Hans-Ulrich (1916–1982)
Rudenko, S. I. (1904–1990)
Ruhr Bombing Campaign
Rumpler Aircraft
Russian Air Force (Post-Soviet)
Ryan Aircraft

Saab Aircraft
Saab J-29 Tunnan
Saab J-35 Draken
Saab J-37 Viggen
Saab JAS-39 Gripen
Safonov, Boris (1915–1942)
SAGE (Semiautomated Ground Environment) Defense System
Saint Mihiel, Battle of (1918)
Saint-Exupéry, Antoine de (1900–1944)
Sakai, Saburo (1916–2000)
Salerno, Battle of (1943)
Salmond, John M. (1881–1968)
Salmson Aircraft
Salyut
Samson, Charles R. (1883–1931)
Santa Cruz, Battle of (1942)
Saro Aircraft
Satellite Command and Control
Satellites
Schmid, Josef (1901–1956)
Schnaufer, Heinz-Wolfgang (1922–1950)
Schriever, Bernard A. "Bennie" (1910–)
Schütte, Johann (1873–1940)
Schwarzkopf, H. Norman (1934–)
Schweinfurt-Regensburg Raids
SENTRY (Samos) Reconnaissance System
Seversky, Alexander P. de (1894–1974)
Seversky Aircraft
Shenyang J-6 and J-8
Short Aircraft (Early Years and World War I)
Short Aircraft (Post–World War I)
Short Stirling
Short Sunderland
Short, Michael C. (1944–)
SIAI Marchetti
Signals Intelligence (SIGINT)
Sikorsky, Igor I. (1889–1972)
Sikorsky S-55/H-19 Chickasaw
Sikorsky S-61R/CH-3/HH-3 ("Jolly Green Giant")
Sikorsky S-64 Skycrane/CH-54 Tarhe
Sikorsky S-65/CH-53 Sea Stallion
Sikorsky S-70
Sikorsky UH-60 Black Hawk
Single Integrated Operation Plan (SIOP)
Six Day War
Slessor, John C. (1897–)
Smushkevich, Yakov "General Douglas" (1902–1941)
SNCASO 4050 Vautour
Sokolovsky, Vasily Danilovich (1897–1968)
Somalia
Somerville, James F. (1882–1949)
Somme, Battle of the (1916)
Sopwith Aircraft
Sopwith, Thomas O. M. (1888–1989)
Sosnowska-Karpik, Irena (1922–1990)
South Atlantic/Trans-Africa Air Route
Southeast Asia Air War (1965–1972)
Soviet Air Force
Soviet Aircraft Development and Production
Soviet Volunteer Pilots
Soviet Women Pilots
Soviet Women's Combat Wings (1942–1945)
Soyuz Space Vehicle
Spaatz, Carl Andrew (1891–1974)
Space Shuttle, and Military Use
Space Stations
SPAD Aircraft
Spanish Air Force
Spanish Civil War
Special Operations
Speer, Albert (1905–1981)
Sperrle, Hugo (1885–1953)
Spruance, Raymond A. (1886–1969)
Sputnik
Squier, George Owen (1865–1934)
Stalingrad, Battle of (1942–1943)
Stapp, John Paul (1910–1999)
Stearman Aircraft
STEEL TIGER (1965–1968)
Steinhoff, Johannes (1913–1994)
STRANGLE (1951)
Strategic Air Command
Strategic Arms Limitation Treaty (SALT)
Strategic Arms Reduction Talks (START)
Strategic Bombing
Strategic Defense Initiative (SDI, "Star Wars")
Strategic Triad Concept
Student, Kurt (1890–1978)
Stumpff, Hans-Juergen (1889–1968)
SUD Aviation
Sueter, Murray (1872–1960)
Suez Crisis
Sugita, Shoichi (1924–1945)
Sukhoi Aircraft
Sukhoi Su-24
Sukhoi Su-27
Supermarine Aircraft
Supermarine Spitfire
Suprun, Stepan (1907–1941)
Sutyagin, Nikolai (1923–1986)
Swedish Air Force

Swiss Air Force
Swiss Aircraft Industry
Syrian Air Force
Systems Management

TACAMO
Tactical Air Command (TAC)
Tactical Air Warfare
Tank, Kurt (1898–1983)
Taran (Ramming)
Taranto Air Attack (1940)
Tarawa, Battle of (1943)
Task Force 38/58
Task Force 77
Taylor, Maxwell Davenport (1901–1987)
Tedder, Arthur W. (1890–1967)
Tereshkova, Valentina (1937–)
Terror-Bombing
Terrorism
Thomsen, Hermann von der Lieth (1867–1942)
Tibbets, Paul W. (1915–)
Tokugawa, Yoshitoshi (1882–1963)
Tokyo Air Raids
Top Gun
TORCH (1942)
Towers, John H. (1885–1955)
Trenchard, Hugh (1873–1956)
Truman, Harry S.
TsAGI
Tsiolkovsky, Konstantin Eduardovich (1857–1935)
Tunner, William H. (1906–1983)
Tupolev Aircraft
Tuskegee Airmen
Twining, Nathan F. (1897–1983)

Udet, Ernst (1896–1941)
Ugaki, Matome (1890–1945)
Ultra
United Aircraft
United States Air Force: Organizational History
United States Air Forces in Europe (USAFE)
United States Army Air Corps (USAAC)
United States Army Air Forces
United States Army Air Service
United States Army Signal Corps
United States Navy
Unmanned Aerial Vehicles
U.S. Air Corps Tactical School (ACTS)
U.S. Air Force Academy
U.S. Air Force Doctrine
U.S. Aircraft Development and Production (World War I)
U.S. Army Aviation: Operations
U.S. Army Aviation: Origins
U.S. Coast Guard Aviation
U.S. Marine Corps Aviation
U.S. Navy, Chief of Naval Operations (CNO)
U.S. Navy, Office of the Secretary
U.S. Postal Air Mail Service
U.S. Strategic Bombing Survey (SBS)

V-1 Missile and V-2 Rocket
Valencia, Eugene A. (1921–)
Vandenberg, Hoyt S. (1899–1954)
Vang Pao (1929–)
VARSITY (1945)
V-Bombers
Verdun, Battle of (1916)
Versailles Treaty
Vertol (Piasecki) H-21
Verville, Alfred (1890–1970)
Vian, Philip L. (1894–1968)
Vichy French Air Force
Vickers Aircraft
Vickers Valiant
Vietnam War
Vietnamese Air Force (North)
Vietnamese Air Force (South)
Vimy Ridge, Battle of (1917)
Vo Nguyen Giap (1912–)
Voisin Aircraft
Voskhod
Voss, Werner (1897–1917)
Vostok
Vought A-7 Corsair II
Vought Aircraft
Vought F4U Corsair
Vought F-8 Crusader
Vought VE-7

Wake Island, Battles of (1941–1945)
Warden, John A. III (1943–)
Warning Systems
Warsaw Pact Aviation
Washington Naval Conference
Weapons System
Welch, Larry D. (1934–)
Wells, Edward C. (1910–1986)
Wells, Herbert George (1866–1946)
Westland Lynx

Westland Lysander
Wever, Walter (1887–1936)
Weyland, Otto P. "Opie"
White, Thomas Dresser (1901–1965)
Whittle, Frank (1907–1996)
Wild Weasel
Williams, Robert R. (1918–)
Wind Tunnels
Winter War (1939–1940)
Women Airforce Service Pilots
Women in Air Combat
Women in the Air Force (WAF)
Women in the Aircraft Industry (World War II)
Women's Auxiliary Air Force
Women's Auxiliary Ferrying Squadron
Worden, Hector (1885–1916)
World War I Aviation
World War II Aviation
World War II Conferences
Wright, Orville (1871–1948)
Wright, Wilbur (1867–1912)
Wright-Patterson Air Force Base
Yakovlev, Aleksandr S. (1906–1989)
Yamaguchi, Tamon (1892–1942)
Yamamoto, Isoroku (1884–1943)
Yeager, Charles E. (1923–)
Yom Kippur War (October War)
Y-Service

Zeppelin, Ferdinand Von (1838–1917)
Zero-Length Launcher
Zuckert, Eugene M. (1911–2000)

FOREWORD

A first in the field of military studies, *Air Warfare: An International Encyclopedia* is a wealth of information—a comprehensive source of names and places, planes and aces, designers and builders. But more than anything it is a record of ideas, developed and brought to fruition over the past century, relating to the conduct of warfare in the third dimension. The men and women, the thinkers and visionaries, the planners and executers of air warfare had new and different ideas about the use of the air—and space—for the prosecution of war and the preservation of peace.

This foreword is meant to unify the sweeping and diverging elements that follow. Most of the writings about air warfare focus on its very visible characteristics—air vehicles and propulsion systems, the victories achieved, the losses suffered, the tons delivered, the damage inflicted—intended and unintended.

Vehicles for air warfare command a wide-ranging mix of such "visibles": materials, design, controls, power plants. And though there has been great diffusion of engineering knowledge across national boundaries, these elements were, and are, largely pursued independently by nations that had the resources to do so. Few nations have successfully fielded effective air forces, yet there is a significant display of visibles that nations throughout history have fielded. The two volumes that make up this ground-breaking publication capture in great detail those visible characteristics and the men and women who dreamed, developed, and deployed them.

Beyond this visible content—and arguably more important to the development of air warfare—are the largely invisible elements that provided the conceptual and analytical basis for designing, funding, producing, deploying, and employing air forces and the logistical framework so necessary for effective use.

Air warfare is fundamentally about new ideas and the resulting new weapons and concepts for their employment; it is not, primarily, about airplanes and pilots; it is not about the platforms from which new weapons are employed. Those elements are the visibles that are the easy to observe and to write about. The unseen and the unreported are much more central to the essence of air warfare and its achievements. The ideas that stimulated and supported war in the third dimension envisioned, and still envision, a changing conflict environment in which air forces would take the fight directly to the political source of an enemy's strength, avoiding the deadly contest at the front. For centuries nations have fought their enemies at the front—from the periphery to the rear—toward some high-priority physical objective, the destruction or threatened destruction of which would cause the enemy to sue for peace.

Airmen had a different idea; they sought to take mortal combat directly to the high-priority objectives—so-called centers of gravity—bypassing the time-honored sacrifice of young men, sometimes by the thousands, at the front. This new notion of war, this new thinking, has received mixed reviews. From questions about its morality—as if killing 50,000 friendly ground forces at the front on separate occasions within a 25-year period did not raise questions of morality for the USA—to questions about its effectiveness, air warfare has generated almost as many detractors as it has supporters. The ensuing intellectual and political debate generated widely divergent views on both sides. The debate has sharpened the critical analysis of air operations far beyond the review and analysis of other areas of warfare, and from that crucible of debate has sprung more pertinent ideas, more compelling concepts, more useful weapons. The introduction of the intercontinental ballistic missile, the ubiquitous employment of space-based capabilities supporting surface and air warfare, the migration and diffusion of reconnaissance from horseback to airplane to spacecraft and, now, to unmanned aerial vehicles demonstrate the capacity of an idea-based movement to adapt to new circumstances—not just new technology, not just piloted vehicles, but to the ideas that drive innovation.

The new ideas associated with air warfare are either revolutionary or conventional depending on one's viewpoint of war as an instrument of national policy. A viewpoint suggesting more revolutionary ideas holds that air warfare changes everything but policy: New means of warfare require new military doctrines and new relationships among the armed forces of a nation; new air warfare capabilities require different planning efforts to maximize the political utility and military power of the evolving force, including air, land, and sea elements; new capabilities afford new concepts of operations and, potentially, less predictable approaches to dealing with enemy forces; incrementalism does not suffice. A viewpoint suggesting that ideas relating to air warfare are more conventional holds that little changes: Human nature has not changed over the millennia; therefore, the causes of, and the events in, war will be familiar; the functions of the armed forces do not change; relationships among combatants may evolve for lots of reasons, but not as the result of any passing technological phenomenon in the third dimension; change in military affairs is continuous, slow, and incremental.

The 1970 pamphlet "Men, Machines, and Modern Times," written by the distinguished naval historian Samuel Eliot Morison, captures the difficulty in acknowledging value and effecting change in traditional military societies (and in the traditional steel and rail industries as well) some 150 years ago. Accepting the advent of the unknowns of steam over the knowns of wind and sail; accepting rifling in the field and deck pieces for armies and navies; accepting breach loaders—each dastardly, revolutionary ideas that were fought hard and for all the wrong reasons. The introduction of breach-loading weapons merits some elaboration: President Lincoln, attempting to recruit and deploy sufficient forces for the Civil War, was effectively opposed, even neutralized, by the insistence of the Union Army's Colonel of Ordnance that federal troops be equipped with muzzle loaders designed a half-century earlier. There are various estimates of the cost of the delay in adapting to the changed circumstances; the patented Colt could, and eventually did, multiply the effectiveness of each soldier so equipped by a factor of two or three. Lincoln's recruiting efforts and the eventual cost of the war were extended by the rejection of change. Adapting to change is a painful exercise for military forces. The burden of history and tradition—and especially of success—is one of the major reasons.

In some 5,000 years of recorded history it appears that man has fought in organized formations on the ground virtually every year (and the same at sea for almost 3,500 years). In the long view of history, air warfare is but a footnote to the vast compendia of battles and heroes of war on land and at sea. Yet the vector of accomplishment demonstrated by air forces in the past 100 years has commanded broad attention and high expectations. In particular, those on the receiving end—on land and at sea—of aerial attack have expressed their respect for the power and impact—physical and psychological—of this still new element of warfare.

Such respect is not universal. There is great tension among the leadership of various service elements in virtually every country over the attention and the approbation paid by the public to the illusion, the promise, and the results of air warfare. This attention is reflected in national debates, policy decisions, and their consequent impact on force structures and operations. The tension manifests itself in many ways and applies well beyond the competition for resources among those who fight in the air, on the ground, and at sea.

Most air forces are subordinate organizational elements of their nations' armies, and the leadership of the army determines, in large measure, the political, doctrinal, and operational environment in which the its force exists. For example, in China the People's Liberation Army Air Force (PLAAF) is an integral arm of the Peoples' Liberation Army. It is not in any way a separate air force, and neither is it an equal player when decisions are made about force development, force structure, and force employment. The purpose of an air force in such an environment is to maximize the contributions of ground combat operations toward achieving the nation's military objectives. The organizational, deployment, and employment concepts of the PLAAF are much more closely aligned with ideas of Alexander, Caesar, and Napoleon than with those of Douhet, Trenchard, and Doolittle. Consequently, the research and development, the training, the standards, the norms, and the operations of the PLAAF are derived from the warfighting needs of the ground forces. Such historical development and the continuing imperatives of traditional ground warfare have limited, in many regards, the potential of air forces to fully exploit the different capabilities inherent in air operations.

These limits are not solely military. In most nations military tradition is embodied in its army. In those few nations with a civil and military seafaring history, the navy may get equal opportunity; nevertheless, for purposes of military involvement in international affairs, for internal security considerations, and in many cases for various internal police powers, the army is the political force of choice when the head of government is seeking a new chief of defense staff (or, in the United States, a new Chairman of the Joint Chiefs of Staff). This selection further limits the breadth of military advice that governments can bring to bear on defense and military issues.

An additional limiting factor has to do with the insight and advice that political leaders can, and do, get from defense intellectuals. Political scientists and classically trained historians understand from their research that war is fought on the ground and on the sea; libraries are full of volumes by men—made famous by their own military exploits and by the work of scholars—who have written in great detail of the formations and the armaments, of the marches and the maneuvers, of the decisions that created victories and defeats. The history of ground and naval warfare is recorded in handsome drawings, outlining the progress of friendly and opposing forces in painstaking detail, including precise time lines, none of which reflect the chaos of real battle. Carefully drawn maps and charts with red lines and blue lines, depicting the positions and the timing that the various forces executed an envelopment or "crossed the T," capture for eternity the tactical analysis and the strategic decisionmaking of the victorious generals and admirals and the triumphs of their forces. Detailed analysis of war from the loser's perspective is rare, and war from an airman's perspective is rarer yet. Airmen typically do not write, and firsthand reports of battles fought from the air are almost nonexistent and becoming more so.

The "first draft of history" is the label that news reporters, particularly in time of war, like to assign to the results of their daily work; they pride themselves in firsthand observation and carefully crafted reports thereof. Churchill made an early name for himself reporting on the Boer War. Today's journalists do the same tasks with somewhat faster transmission of their stories. Even Churchill, careful observer that he was, would have great difficulty covering today's aerial operations—few combatants, small cockpits, no space for observers, hundreds of miles deep in enemy territory, closing speeds of 500–1,500–15,000 miles per hour, unseen electronic combat, stealthy participants on both sides—and submitting gripping copy.

All of this captures how aerial warfare is differentiated by outside observers from warfare on the ground and at sea: Only the effects of air operations are observable, measurable, and reportable. For ground and sea operations, reporters can see, touch, and feel; the activity is the story—the forced march, the thunder of shelling, the smell of cordite, the after-action interview, the personal sense of fear and camaraderie with the engaged troops. For air operations reporters, in large measure, can report only on results. There are more reports by far of the preparation of the aircraft and weapons, the launching and the recovery of missions from aircraft carriers, than of the conduct of combat operations by naval aviators and their formations. For the news industry the story is about "how the game is played." Who won is of some interest, but the preferred story is one that follows the ball play-by-play, that fills airtime and column inches, that captures the feelings of the wounded sergeant, that permits the reporter to do the "standup shot" in front of the burning hulk. The preferred story covers individual bravery and unit actions with evident risk-taking and on-scene heroes. How the game is played by modern air forces is unseen, untold, and unreported, and consequently history books will continue to accumulate a disproportionate amount of data and analysis on ground warfare. Some are very good; other works, for example, *Certain Victory: The U.S. Army in the Gulf War,* by (Major General) Robert H. Scales Jr., will unfortunately fill libraries and scholars with seriously flawed data. Certain Victory is a pompous, self-congratulatory dream about the Gulf War of 1990–1991; it is a press-agent approach to scholarly writing about war, and unfortunately policy analysts will continue to cite it.

For several reasons the person on the street is interested in results; he has sons and daughters, nieces and nephews; he is interested in peace and prosperity, not glory and laurels. If unseen and unreported air operations can secure his interests, he is not confused by the perspective of intellectuals in the media and elsewhere. In the United States the most widely attended outdoor attractions are air shows; Americans are captivated by airplanes, aviation, and aviators. It is probably not an accident that the first man to fly was an American; the first to cross the Atlantic solo was an American; the first to fly supersonic was an American; the first to walk on the moon was an American. Americans have been, and are, fascinated by air and space accomplishments and reflect this fascination in their political and financial support of advancing air and space developments.

A consequence of this fascination is high expectations of air operations, air forces, and air commanders. The political and public fallout of an air incident are far more widely reported, investigated, and acted on than a similar event in any other medium. These considerations apply to military forces. For example, the terrorist attack on the USS Cole in the port of Aden, Yemen, in 1998 resulted in the deaths of 18 sailors, a naval court of inquiry into the performance of the ship's captain, and a determination of no formal administrative or judicial action; a terrorist attack on Khobar Towers in Dhahran, Saudi Arabia, in June 1996 resulted in the deaths of 18 airmen, an investigation by a politically appointed outsider, and public humiliation for the air commander; an ill-conceived operation in Somalia, a U.S. initiative, resulted in the deaths of 19 soldiers and has yet to be investigated. Expectations are higher; the standards are different for airmen.

Higher expectations are also reflected in the treatment of results, intended and unintended. Air operations are no doubt a blunt instrument of national policy; they deal with weapons in tons; they have a history, brief as it is, of scattering those tons approximately 1,000 feet, more or less, around (World War II–era) aiming points. Even today, with much more precise technology and techniques, it is not unusual to hear of unintended or "collateral" damage from air-delivered weapons. It is highly unusual, however, to hear of collateral damage from friendly sea and ground operations. Villages, towns, and cities overrun by mechanized infantry or armored divisions seldom generate complaints of collateral damage; weeks, months, or years later, when the displaced persons finally return to their homes, they are more interested in rebuilding—and news reporters have found fresher stories. The prevalence of TV cameras, the depth of air operations in enemy territory, and the utility for enemy information warfare (propaganda) purposes make collateral damage stories the preferred option for depicting air warfare.

Selected physical damage, vivid images of "innocent civilians," and anguished interviews by survivors make air warfare appear dysfunctional to the political solution of the problem at hand. Ground and surface naval forces are highly unlikely to damage or destroy the embassy of a great power; air warfare bears a special burden. The reality is, in all areas of warfare, death, dismemberment, damage, and destruction—intended and unintended—are the essence of combat operations; the more successful a nation is in limiting unintended results, the more egregious the remaining examples will seem. As for intended results, because there are no moving lines on the ground and there are no easily observed and measured symbols of "advance," air operations may appear ineffective until a political collapse occurs, until the enemy forgoes military (for diplomatic) action. The few examples where air forces were permitted to take a leading role—the Berlin Airlift, the LINEBACKER operations, the Falklands campaign, the Gulf War, Kosovo—have resulted in prompt and effective operations with a minimum cost in blood and treasure.

Four fundamental assumptions were held by the early visionaries of air warfare and are held by today's day-to-day operational air commanders in every theater of operations. Air forces will be able to: identify, find, hit, and destroy high-priority objectives. These assumptions were, and are, sometimes valid.

Not until the last twenty years of the twentieth century did the technical tools and the operational techniques start to become widely available to give high confidence that virtually all delivery vehicles would routinely solve the navigation problem and find the assigned objective. The introduction of inertial navigation equipment and the Global Positioning System gives those nations that have the means to install and train with this equipment virtual assurance that missions will arrive in the assigned objective area. The next issue—hitting the assigned target or target area, using the correct coordinates, and placing the aiming device on the correct physical entity—is not trivial. Although there have been great technical advancements in precision-guided weapon development, there are natural and enemy-created impediments. Weather affects all military and naval operations, and even the latest weapons and guidance systems are not immune from these effects. Enemy-created effects are broader: active and passive defenses, concealment, deception, camouflage, movement—all serve to complicate the end-game difficulty of dealing with an assigned objective. Nevertheless, the probability of hitting, photographing, or resupplying the assigned objective is a high-probability event today for appropriately prepared forces.

The issue of sufficient damage or destruction, given that the objective is struck, is an enduring challenge. Matching the most appropriate weapon to the characteristics of the target is an art; doing so while minimizing collateral damage is a fine art. Hardening fixed facilities and replicating the critical components of high-value potential targets will make damage and destruction continuing issues; a bigger hammer is not necessarily the answer; the answer in many cases is a vulnerability analysis and selection of the key node. This is part of the enduring intellectual problem of warfare, to which we turn next.

To identify the most appropriate objective, or the most appropriate element embedded within a target area, is the major continuing challenge of air warfare. Choosing the most appropriate objectives, prioritizing across a broad area of operations, and identifying the most critical enemy function or functions that can, individually or in conjunction with a coherent campaign plan, best achieve the nations war aims in the quickest and most economical manner are the problem for air-war planning. The difficulty of allocating scarce resources against the most appropriate military objective in an active enemy system is the most demanding intellectual problem faced by war planners. All of the competitive issues seen in modern business and athletic competition are brought to bear—with the added complexity of the sure knowledge that the opponent, at best, is doing everything in its power to kill each friendly competitor and, at worst, to destroy the armed forces and the social fabric of the friendly nation or nations.

This burden of identifying the most appropriate objective falls, of course, on all military and naval commanders; however, for air commanders it is arguably a more complex problem because ranges, payloads, and potential military and political impacts have greater scope. Furthermore, the most appropriate objectives are likely to be critical components of organic systems—the communications, the transportation, the electrical power, the petrochemical, the other industrial, the agricultural, and the military and political infrastructures—that underpin the enemy's power base. In World War II air forces contented themselves with striking facilities—enemy headquarters, air bases, rail yards; today the standard is to cripple the military and political functions that the facilities support. Today the standard is to achieve specific operational effects within the enemy's political and military system; this, in turn, demands serious insight into the enemy's organization well beyond order-of-battle analysis. Such functional understanding of enemy doctrine and procedures is in itself a powerful weapon, but it is not free of costs.

A consequence of the imperative to identify the most appropriate operational effects and the related objectives for air operations is a requirement to maintain an intelligence function fine-tuned to the new standards. The easy answer for most nations is the amorphous central and defense intelligence agencies that produce products pitched to the needs of the policy establishments. These nations have structured their collection and reporting assets so that the military commanders—except for actions such as prisoner interrogations and documents collected on the battlefield—are the last to have access to important strategic and operational intelligence. The more technology has advanced, the greater the investments in strategic and national intelligence systems and the greater the gap between the capability of military forces and their capacity for operational assessment and decisionmaking—effective operational intelligence. For the United States this gap is abundantly apparent in recent events in Aden, Somalia, Serbia, and elsewhere.

Another area for which "one size fits all" is the wrong answer is logistical support of combat forces. Ground, naval, and air forces have major real differences in operating environments that shape service doctrine and philosophy and that, in turn, drive design, size, shape, firepower, mobility, maintainability, and reliability of service equipments. The notion—prompted largely by financially savvy policymakers with little or no interest and experience in military and naval affairs—that service equipments ought to be commoditized—conceived, acquired, and maintained by a civilian entity that could enforce commonality—is a creeping disease endemic in virtually all democratic nations. Virtually every senator or member of parliament in every nation around the world understands air operations; they fly home almost every weekend; they assess takeoffs, landings, and on-time arrivals. They would not dream of advising a submarine captain on operations, but airmen are fair game.

For air warfare this notion of commoditization—commonality at all costs—is particularly painful; the development of new ideas has been fostered in various nations by the willingness of airmen and astronauts to experiment beyond the edges of conventional thinking, to engage a broad cross-section of scientists and strategists to explore unconventional methods to achieve engineering, tactical, and operational results. In the United States the demise of Air Force Systems Command was a seminal event, limiting what had been a hugely successful enterprise devoted to assembling the best thinkers available, military and civilian, to bring the possibilities of science and engineering to bear on emerging military problems. The elimination of this organization portends the decline of U.S. military air and space leadership.

Similarly, the structure of the maintenance, supply, distribution, and data systems that support military forces needs to adjust to the operating patterns and performance of the supported force. Air forces operate from long distances, often from sanctuaries well outside the area of operations; the ability to connect regularly and efficiently to a centralized logistical system on virtually an hourly basis changes the materials and the skills required at each location for the conduct of operations. Armies and navies, in contrast, are typically not so well connected to global air transportation nets and thus require different and more extensive sets of on-hand machinery, materials, and skills to manufacture and repair critical parts.

Global air transportation is the least heralded element in air warfare. Unrecognized by the early air warfare thinkers—who wrote extensively about bomber, pursuit, and observation tasks—military airlift evolved from an appreciation for the growing utility of civil aviation fleets; civilian aircraft were embraced to do similar tasks in a military situation. From the World War II regional experience of flying the Hump, to the Berlin Airlift, to Operation NICKEL GRASS (the strategic resupply of Israeli forces in 1973), to the deployment and redeployment of warfighting and peacekeeping forces around the world, air transportation fleets have become the sine qua non of conflict management. The Berlin Airlift is, arguably, the twentieth century's premier example of military art at its highest level of accomplishment—no "combat" casualties, yet the allied powers achieved their strategic goals, preserved the political status of, and access to, Berlin, and set the tone for the next fifty years of European political and military history. Many nations have found the political and economic tools to integrate military and civilian air transportation into global strategic lift capability.

Since the beginning of the Cold War the United States has deployed, supported, and redeployed, by air, significant military forces for operations in Korea, Western Europe, Southeast Asia, and Southwest Asia plus smaller forces to Panama, Somalia, Bosnia, Kosovo, and Afghanistan. This view of global transportation includes the aerial "transportation and delivery" fuel to extend the range and duty time of other forces, including other lift, surveillance, bomber, fighter, and space vehicles. There is no historical precedent for the global scope of major operations conducted by U.S. forces during this period. The combination of inflight refueling, intercontinental strategic airlift, and the more local tactical airlift is the crucial determinant of force deployment and, in many cases, force sustainment. Strategic mobility is a very operational capability. Whereas heavy materiel typically moves by commercial sealift, personnel, high-value supplies, and casualty evacuation are important airlift tasks. Moreover, the U.S. fleet of T-tailed aircraft is the transportation mode of choice for every peacekeeping and humanitarian mission conducted by blue-helmeted troops and others worldwide.

The term "independent air force" has, for better or for worse, confused and complicated the debate about the development and employment of air capabilities. Air forces clearly cannot exist "independent" of the structures and the operational activities of the rest of a nation's military establishment. Air forces need to be and must be integrated into the totality of the nation's forces. The potential contributions of an independent air force need to be viewed, however, through eyes untainted by the burden of traditional military history. Training, logistics, and intelligence, among other functions, that suffice, or even excel, at the pace a rhythm of ground or sea operations have little in common with the needs of air and space warfare. The most appropriate objectives for tactical and operational planning are different depending on the vision and experience of the commander in chief. Those who argue for independent air operations ask that their forces be valued for their independent contributions to the war effort and not solely for their contributions to maximizing the combat power of some other element. This is not an argument for anarchy or autonomous air action. Some overall political and military authority, with the best interests of the nation in mind and a sophisticated view of operational possibilities, must orchestrate all of the military tools available to force an early end to hostilities on favorable terms.

Navies seem to have found a way to balance the new with the old. For those nations with a substantial naval component, the fleet has reoriented itself to fully exploit modern offensive and defensive capabilities. Submarines, occasionally, and aircraft carriers are the visibles of modern navies; both are accommodated in integrated operations. Fleets are built around carriers; fleet operations are built around carrier operations, which, in turn, are built around air operations.

Even in those circumstances where there is an independent air force, the history and the politics of each nation have typically hobbled the application of air capabilities to the views, history, and operational experience of the nation's senior service. Thus, the elegant Australian War Memorial in Canberra, with its columns and columns of war dead, listed battalion after battalion, overwhelmingly from the doomed battle at Gallipoli, has defined for years, and will define for many decades, if not centuries, the historical image of Australian war experience, the willingness to serve, the sacrifice made. This image has colored, and will continue to color, the military leadership that Australian politicians choose and thus the nature of the advice they will receive from the senior military leadership, regardless of the nature of the extant political-military circumstances.

I do not argue that air forces and air force leaders have better advice to give than do competent military professionals from other backgrounds. I do argue that airmen are not wedded to thousands of years of history and tradition and therefore have less intellectual and institutional baggage in giving sound military advice.

Two observations by senior commanders will suffice to bookend the traditional views of many ground-force officers concerning contributions of air operations to the conduct of warfare. The first is a quote from Douglas Haig, prior to becoming commander in chief of the British Expeditionary Force during World war I, in a 1914 address to the British Army Staff College: "I hope none of you gentleman are so foolish as to think that aeroplanes will be usefully employed for reconnaissance from the air. There is only one way for a commander to get information by reconnaissance and that is by the use of cavalry."

The second comes thanks to Wesley K. Clark, the retired U.S. Army general who was the senior U.S. military commander in Europe and senior commander for the North Atlantic Treaty Organization during the 1999 war in Kosovo. In his memoirs he took no cognizance of the contributions of air operations to the NATO effort (except for two chapters on Task Force Hawk, the 5,000-man, 24-helicopter U.S. Army unit that did not participate in combat operations). The B-2 bomber—the stealth platform that penetrated Serbian air defenses with impunity and served as the workhorse of General Clark's engaged forces—is not mentioned.

Notwithstanding the views of traditionalists, air warfare has proven itself a valuable addition to the tools of statecraft. At the publication of *Air Warfare: An International Encyclopedia,* the centennial anniversary of the first successful flight of a heavier-than-air machine has yet to come to pass, and humanity's initial ventures into space are barely 40 years old. Yet the pace of new ideas, the introduction of new concepts, and their translation into valued instruments of national power is breathtaking. Nations that can find the considerable resources required to field effective air forces can enhance the value of their traditional forces and can use this rapidly evolving instrument of military power to better preserve, protect, and defend their interests, wherever they may be.

—*Mike Dugan*
General, USAF (Ret.)

PREFACE

In planning this encyclopedia with my colleagues, many goals were set forth, but there were three that we considered most important. The first was to include entries that provided information on the most significant individuals, events, weapons, industries, strategies, and tactics of the roughly 200-year history of international airpower. The second was to make an initial assessment of the importance of each entry. The third was to reach out to the entire aviation community for contributions and to preserve, insofar as possible, the original flavor of those contributions. There were many aspects to this process. Some authors were distinguished scholars, long accustomed to writing encyclopedia entries, and integrating their work was straightforward. Some authors were experts in their fields but not academics, and so their entries were sometimes less formal. Other authors were so technically expert that their entries had to be simplified to be understood by the average reader, yet their exact meaning had to be preserved. In yet other instances, some entries reflected the fact that English was not the scholar's native tongue. Because we tried to keep all the entries as original as possible, entries written by foreign scholars were revised only for the sake of clarity.

The methods we employed were direct. We made an appeal to the academic community as well as to the legion of aviation historians that specialized in various areas of airpower history. In attempting to provide a broad coverage, we understood that some elements of airpower history had already been well described in the past and were easily accessible to the reader. Still, some elements had been virtually ignored. Based on this understanding, we decided to sometimes limit the coverage of well-known subjects while giving greater coverage to those less well known.

There were some obvious trade-offs that had to be considered. Given that there was a limit on the size of the encyclopedia, a decision had to be made as to the number of entries to be included. If fewer topics were selected, more words could be devoted to each. If more topics were included, each would contain fewer words. Our initial list ran to roughly 1,300 entries, but it soon became evident that this was too many. We were also presented with many new ideas from the contributors, often reflecting their specialized interests, and this caused a continuous evaluation of which entries to retain and which to sacrifice.

As a result of these deliberations, we settled on some 990 entries running nearly 500,000 words. The length of a given entry can vary, from as few as 100 words to as many as 7,500 words. Our saving grace was often the cross-references provided at the end of most entries. These guide the reader to additional information on the subject and, of course, lead to still more sources of scholarship.

In making these difficult decisions, an iterative process was established with the editors and the contributors. An initial list was reduced and circulated, and the contributors who elected to participate responded with observations and suggestions that ultimately resulted in encyclopedia you now see. I should also mention that this work owes a great debt to the Internet and its related technology, which made the entire process possible and was an invaluable way to reach new contributors, many in foreign countries.

A note on the use of specialized terminology, acronyms, and abbreviations: Given the complexity of the subject matter, we have tried to be as consistent and clear as possible. Common acronyms appear in the entry's headword; other acronyms are typically defined at first instance within an entry. Widely recognized acronyms, such as USAF and RAF, are not formally defined in the text. To help the reader keep track of the many acronyms and abbreviations, we provide a complete list of terms, acronyms, and abbreviations. We encourage readers to rely on this comprehensive list of airpower-related terminology.

I would like to express my gratitude to my associate editors—all distinguished in their fields—who made so many insightful suggestions and contributions. In alphabetical order, they are Michael Fopp, director of the Royal Air Force Museum; Fred Johnsen, a noted author and historian; Stéphane Nicolaou, curator at the marvelous Musée de l'Air et de l'Espace at Le Bourget Field, near Paris, and a well-known author; and the indefatigable George M. Watson Jr., a U.S. Air Force historian whose many suggestions and quick responses to my calls made the task easier. My admiration for Spencer C. Tucker is unbounded, for I now know the effort he has put forth in editing other encyclopedias. Spence was good enough to ask me to participate, and I thank him for the experience. It is a delight to work with the people at ABC-CLIO, especially Alicia Merritt and Liz Kincaid. Wally Meeks, as usual, was helpful with his good ideas.

My most appreciative and humble thanks go to the contributors, whose entries were fascinating to read and whose patience with my nagging was remarkable. Not only did they work willingly and punctually; they were also the source of most of the photographs you will find in the two volumes. I also want to express my appreciation to a few would-be contributors who signed on but could not deliver; I know that circumstances must have prevented your participation, and want you all to know that the editors and contributors understand.

Finally, I cannot put into words the gratitude I feel to my family, who cheerfully put up with my submersion at the computer as I worked to bring this project to fruition.

—*Walter J. Boyne*
Ashburn, Virginia

MAPS

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TERMS, ACRONYMS, AND ABBREVIATIONS

AA	antiaircraft
AAA	antiaircraft artillery
AAF	Argentine Air Force
AAMs	air-to-air missiles
AB	Agusta-Bell
ABCCC	Airborne Battlefield Command and Control Center
ABDA	American, British, Dutch, Australian
ABL	airborne laser
ABM	antiballistic missile
ACCS	Air Command and Control System; also: Airborne Command and Control Squadron
ACFC	Air Corps Ferrying Command
ACG	Air Commando Group
ACTS	Air Corps Tactical School
ACWP	Automotive Council of War Production
AD	Air Division
ADC	Air (Aerospace) Defense Command
ADRC	Air Documents Research Center
ADVON	Advanced Echelon
AEA	Aeronautical Experiment Association
AEF	Aerospace Expeditionary Force
AEW	airborne early warning
AF	Air Force
AFB	Air Force Base
AFC	Armed Forces Council
AFDD	Air Force Doctrine Document
AFM	Air Force Manual
AFMC	Air Force Material Command
AI	air interdiction
AIRCENT	Allied Air Forces Central Europe
ALAT	Army Light Air Force
ALCS	airborne launch-control system
ALERT	Attack and Launch Early Reporting to Theater
AMC	Air Mobility Command
AME	Aeronautica Militar Espanola
ANG	Air National Guard
ANR	Aeronautica Nazionale (National) Repubblicana
AOC	air officer commanding
ARM	antiradiation missile
ARPA	Advanced Research Projects Agency
ARRS	Aerospace Rescue and Recovery Service
ARVN	Army of the Republic of Vietnam
ASAT	antisatellite
ASC	Air Support Command
ASM	air-to-surface missile
ASTS	Air Service Tactical School
ASW	antisubmarine warfare
ATC	Air Transport Command
ATF	Advanced Tactical Fighter
ATGM	antitank guided missle
ATI	air technical intelligence
AVG	American Volunteer Group (Flying Tigers)
AWACS	Airborne Warning and Control System
AWPD	Air War Plans Division
BAe	British Aerospace
BAP	Bureau of Aircraft Production
BCATP	British Commonwealth Air Training Plan
BFW	Bayerische Flugzeugwerke
bhp	brake horsepower
BIS	British Interplanetary Society
BMEWS	Ballistic Missile Early Warning System
BNA	Bureau of Naval Aeronautics
BPF	British Pacific Fleet
BPR	bypass ration
CAB	Caproni Aeronautica Bergamasca
CACW	Chinese-American Composite Wing
CAF	Chinese Air Force
CAP	Civil Air Patrol; Combat Air Patrol
CAS	close air support
CAT	Civil Air Transport

CATF China Air Task Force
CBI China-Burma-India
CBO Combined Bomber Offensive
CCP Chinese Communist Party
CENTAF United States Central Air Forces
CEO chief executive officer
CETF College Eye Task Force
CGS Continental Ground Station
CIA Central Intelligence Agency
CINC commander in chief
CINCPAC Commander in Chief, Pacific Fleet
CIS Commonwealth of Independent States
CNAC China National Aviation Corporation
CNO Chief of Naval Operations
CNT Cantiere Navale Triestino
COMINCH commander in chief of the U.S. Fleet
COMUSMACV U.S. Military Assistance Command, Vietnam
CONAC Continental Air Command
CONAD Continental Air Defense Command
CPTP Civilian Pilot Training Program
CRAF Civil Reserve Air Fleet
CRDA Cantieri Riuniti Dell'Adriatico
CRT cathode-ray-tube
CSAR Combat Search and Rescue
CSAS Comando Servizi Aerei Speciali (Special Air Services Command)
CTA Centro Tecnico Aerospacial
CVE escort carrier
DARPA Defense Advanced Research Projects Agency
DASC Direct Air Support Center
DATF Desert Air Task Force
DCNO (Air) Deputy Chief of Naval Operations for Air
DFC Distinguished Flying Cross
DMSP Defense Meteorological Satellite Program
DMZ demilitarized zone
DNSS Defense Navigation Satellite System
DOD Department of Defense (U.S.)
DOS Department of State (U.S.)
DRA Democratic Republic of Afghanistan
DRV Democratic Republic of Vietnam
DSC Distinguished Service Cross
DSP Defense Support Program
DVS Commercial Pilot Training School
EAP Experimental Aircraft Program
ECCM electronic counter-countermeasures
ECM electronic countermeasures
EDA Ejército del Aire
EGNOS European Global Navigation Overlay System
ELINT electronic intelligence
EOP Executive Office of the President
ER/ELINT electronic reconnaissance/intelligence
ESM Electronic support measures
ETO European Theater of Operations
EVA extravehicular activity
EW Electronic warfare
FAA Fleet Air Arm
FAC forward air control/controllers
FAH Fuerza Aerea Hondureña
FBW fly-by-wire
FEAF Far East Air Forces
FECOM Far East Command
Fliegerkorps Luftwaffe air corps
FM Field Manual
FMA Fabrica Militar de Aviones (Military Aircraft Factory)
FSTA Future Strategic Tanker Aircraft
GCI ground-controlled interceptor
GEO geostationary orbit
GGS Gyro Gun Sights
GHQ General Headquarters
GHQ AF General Headquarters Air Force (U.S.)
GIAP Gvardeiskii Istrebitelnyi Aviatsionnyi Polk (Guards Fighter Air Regiment, Soviet Union)
GLONASS Global Navigation Satellite System
GNBAP Gvardeiskii Nochnoi Bombardirovochnyi Aviatsionnyi Polk (Guards Night Bomber Air Regiment, Soviet Union)
GNSS Global Navigation Satellite System
GPS Global Positioning System
GSDF Ground Self-Defense Force
GvNBAP Guards Night Bomber Aviation Regiment (Soviet Union)
Himmelbett German radar system for night fighters
hp horsepower
HQ headquarters
HSA Hawker-Siddeley Aircraft
HSD Hawker-Siddeley Dynamics
HSU Hero of the Soviet Union
HUD head-up display
IADS integrated air defense systems
IAF Israeli Defense Force/Air Force
IAI Israel Aircraft Industries
IAK Istrebitelnyi Aviatsionnyi Korpus (Fighter Air Corps, Soviet Union)
IAP Istrebitelnyi Aviatsionnyi Polk (Fighter Air Regiment, Soviet Union)
ICBM intercontinental ballistic missile
IDSCS Initial Defense Satellite Communications System
IFR Instrument Flight Rules
IJN Imperial Japanese Navy
IMAM Industrie Meccaniche e Aeronautiche Meridionali
IOC Initial Operational Capability
IQAF Iraqi Air Force
IR infrared

IRBM	intermediate-range ballistic missile
ItAF	Italian Air Force
JAAF	Japanese Army Air Force, Imperial
Jagdgeschwader	Luftwaffe fighter wing
Jagdstaffel (Jasta)	Luftwaffe fighter squadron
Jagdverband	Luftwaffe fighter unit
JASDF	Japanese Air Self-Defense Force
JATO	jet-assisted takeoff
JCS	Joint Chiefs of Staff
JNAF	Japanese Naval Air Force, Imperial
JPO	Joint Program Office
JSDF	Japanese Self-Defense Forces
JSF	Joint Strike Fighter
JSOTF	Joint Special Operations Task Force
Kampfgeschwader	Luftwaffe bomber wing
kph	kilometers per hour
Kriegsmarine	German Navy
LAMPS	Light Airborne Multipurpose System
Lichtenstein	type of German airborne radar
LORAN	long-range electronic navigation
LPS	Large Processing Station
LRP	Long-Range Penetration
Luftfahrtruppe	German aviation troops
Luftflotte	Luftwaffe air fleet
Luftstreitkräfte	German Air Service (World War I)
Luftwaffe	German Air Force (World War II)
MAAF	Mediterranean Allied Air Forces
MAAG	Military Assistance Advisory Group Vietnam
MAC	Military Airlift Command
MACV	Military Assistance Command Vietnam
MAD	magnetic airborne detection; mutual assured destruction
MAL	mat-landing
MANPADS	man-portable air defense system
MATS	Military Air Transport Service
MCM	mine countermeasures
MCT	Mobile Communication Terminal
MEO	middle-earth orbit
MGS	Mobile Ground System
MGT	Mobile Ground Terminal
MHz	megahertz
MIDAS	Missile Defense Alarm System
MIRACL	Mid-Infrared Advanced Chemical Laser
MIRV	Multiple Independently Targetable Reentry Vehicle
MIT	Massachusetts Institute of Technology
mm	millimeter
mph	miles per hour
MRBM	medium-range ballistic missiles
MRC	Military Revolutionary Council
MSDF	Maritime Self-Defense Force
MTU	Moteren und Turbine Union

NACA	National Advisory Committee for Aeronautics
NAF	Naval Aircraft Factory
NAP	naval aviation pilot
NASA	National Aeronautics and Space Administration
NASAF	Northwest African Strategic Air Forces
NATO	North Atlantic Treaty Organization
NATS	Naval Air Transport Service
NAVAIDS	aids to navigation.
NAVFE	Naval Forces Far East
NAVSTAR	Navigation Satellite Time and Ranging
NBAP	Night Bomber Aviation Regiment (Soviet Union)
NBS	National Bureau of Standards
NCO	noncommissioned officer
NEACP	National Emergency Airborne Command Post
NIAP	Nochnoi Istrebitel'nyi Aviatsionnyi Polk (Night Fighter Air Regiment, Soviet Union)
NLC	National Leadership Committee
NORAD	North American Air Defense Command
NPT	Nuclear Non-Proliferation Treaty
NRO	National Reconnaissance Office
NSA	National Security Act of 1947; also: National Security Advisor
NSC	National Security Council
NVA	North Vietnamese Army
NVAF	North Vietnamese Air Force
OGS	Overseas Ground Station
ONR	Office of Naval Research
OPEC	Organization of Petroleum Exporting Countries
OSS	Office of Strategic Services
PACAF	Pacific Air Forces
PACOM	Pacific Command
PAF	Pakistan Air Force
PAVN	People's Army of Vietnam (North Vietnamese Army)
PGMs	precision-guided munitions
PLAAF	People's Liberation Army Air Force (Chinese Communist Air Force)
PLSK	Pomonicza Lotnicza S-UBA Kobiet (Auxiliary Women's Air Force Service, Poland)
POL	petroleum, oil, lubricants
POW	prisoner of war
PPI	plan position indicator
PVO	Voiska Protivovozdushnoi Oborony (Antiaircraft Defense Forces, Soviet Union)
PWS	Podlaska Wytwornia Samolotow
PZL	Panstwowe Zaklady Lotnicze (National Aviation Establishments, Poland)
RA	Regia Aeronautica
RAE	Royal Aircraft Establishment
RAF	Royal Air Force
RAND	Research and development think tank
RCAF	Royal Canadian Air Force

REAF	Royal Egyptian Air Force
Reichsluftverteidigung	Air Defense of Germany
RFC	Royal Flying Corps
RGS	Relay Ground Station
Riesenflugzeug	giant aircraft
RLA	Royal Laotian Army
RLM	Reich Air Ministry
RN	Royal Navy
RNAF	Royal Norwegian Air Force
RNAS	Royal Naval Air Service
ROC	Republic of China
ROE	Rules of Engagement
ROTC	Reserve Officer Training Corps
rpm	revolutions per minute
RTAF	Royal Thai Air Force
RVN	Republic of Vietnam
RVNAF	Republic of Vietnam Air Force
RYAF	Royal Yugoslav Air Force
SA	selective availability
SAAC	Swiss American Aircraft Corporation
SAC	Strategic Air Commansd
SAGE	Semi-Automatic Ground Environment
SAR	search and rescue
SARH	semiactive radar-homing
SARTAF	Search and Rescue Task Force
SBIRS	Space-Based Infrared System
SBS	United States Strategic Bombing Survey
Schlachtstaffel	Luftwaffe battle flight
Schräge Musik	German upward-firing armament
SEAD	suppression of enemy air defenses
Seeluftstreitkräfte	German naval air force
Seenotdienst	Luftwaffe air rescue service
SEP	specific excess power
shp	shaft horsepower
SIAI	Società Idrovolanti Alta Italia
SIGINT	signals intelligence
SIOP	Single Integrated Operation Plan
SL	Schütte-Lanz airship factory
SLBM	submarine-launched ballistic missile
SNCA	Société Nationale de Constructions Aéronautiques (National Aircraft Building Company)
SOCONY	Standard Oil of New York
SOF	Special Operations Forces
SPS	Simplified Processing Station
SRBM	short-range ballistic missile
Staffeln	Luftwaffe squadrons
STC	Satellite Test Center
STOL	short takeoff and landing
SVAF	South Vietnamese Air Force
TAC	Tactical Air Command
TACAN	Tactical Air Navigation
TACC	Tactical Air Control Center
TBMs	tactical ballistic missiles
TEREC	tactical electronic reconnaissance sensor
TFA	Task Force Alpha
TOA	time-of-arrival
TOW	tube-launched, optically tracked, wired-guided missile
TsAGI	Tsentral'nyi Aero-Gidrodinamicheskii Institut (Central Aerodynamics and Hydrodynamics Institute, Soviet Union)
UAC	United Aircraft Corporation
UATC	United Aircraft and Transport Corporation
UAV	uninhabited aerial vehicle
UCAV	uninhabited combat aerial vehicle
UN	United Nations
USA	United States Army
USAAC	United States Army Air Corps
USAAF	United States Army Air Forces
USAF	United States Air Force
USAFE	United States Air Forces in Europe
USAFFE	United States Army Forces Far East
USMA	United States Military Academy
USN	United States Navy
USSR	Union of Soviet Socialist Republics
USTRANSCOM	United States Transportation Command
VC	Vietcong
VIP	very important person
VLF	very-low-frequency
VOR	Very High Frequency Omnidirectional Radio Station
VORTAC	a combination of VOR and TACAN
VSTOL	very short takeoff and landing
V/STOL	vertical/short takeoff and landing
VTOL	vertical takeoff and landing
VVS	Vozdushno-voennye Sily (Air Forces, Soviet Union)
WAAF	Women's Auxiliary Air Force
WAF	Women in the Air Force
WAFS	Women's Auxiliary Ferrying Squadron
WASP	Women Airforce Service Pilots
WDD	Western Development Division
WFTD	Woman's Flying Training Detachment
WPB	War Production Board
WRAF	Women's Royal Air Force
ZAT	territorial air zone
ZEL	zero-length launcher

AIR WARFARE

An International Encyclopedia

A

Aces

According to the traditional definition, an "ace" is a fighter pilot who has attained five confirmed kills of enemy aircraft. Though not technically an ace by this standard, World War I French pilot Roland Garros began the tradition of aerial combat with a clever ploy. He devised a means to shield his wooden propeller with metal so a machine gun could shoot through the arc (bullets that hit the blades would ricochet off). In a mere 18 days in early 1915, he shot down three German aircraft and claimed two others. Press reports of his exploits were the first to use the French slang "ace" to mean at least five enemy aircraft downed—although the term soon came to require five or more *confirmed* aircraft shot down. The German word was *kanone,* indicating a star turn; 10 victories were required for that designation.

The French definition of five confirmed became accepted during World War I and reappeared in later wars. The idea of achieving ace status quickly became popular among fliers and the general public. As World War I degenerated into static trench warfare with horrific losses and virtually no glory, the contests among pilots to raise scores achieved considerable public following. The pilots became the heroes whom people needed in a protracted and bitter war. And they were heroes in later wars as well.

The following table lists the highest-ranking aces from several conflicts since 1914. An excellent study by Al Bowers and David Lednicer indicates that there may have been as many as 10,000 aces in at least 27 countries, and some women also became aces.

World War I (1914–1918)

These totals of kills include balloons and aircraft; both were fighter targets. This listing is selective but includes the top aces of the major powers.

Manfred von Richthofen, Germany, 80
Rene Fonck, France, 75
E. C. Mannock, Britain, 73
W. A. Bishop, Britain, 72
Ernst Udet, Germany, 62
R. Collishaw, Canada, 60
J. T. B. McCudden, 57
Georges Guynemer, France, 54
A. W. Beauchamp-Proctor, South Africa, 54
D. R. MacLauren, Canada, 54
Charles Nungesser, France, 45
Godwin Brumowski, Austria-Hungary, 40
Oswald Boelcke, Germany, 40
Willy Coppens, Belgium, 37
Francesco Baracca, Italy, 34
Edward Rickenbacker, U.S., 26

Spanish Civil War (1936–1939)

Many of these pilots later attained even higher scores while fighting World War II; the list below includes the top aces on either side of the civil conflict.

Joaquin García Morato y Castaño, Nationalist, 40
Andres García Lacalle, Republican, 11+

China-Japan-Manchuria (1937–1945)

This theater became part of World War II but was fought over a longer period. The American Volunteer Group (the Flying Tigers) were in action on behalf of China in 1941–1942, totaling 286 confirmed kills. Only the top scorers are listed:

Hiromichi Shinohara, Japan, 58
Mitsuyoshi Tarui, Japan, 28

Kenji Shimada, Japan, 27
Robert Neale, AVG, 16
David Lee Hill, AVG, 12
Liu Chi-Sun, China, 11

Russo-Finnish Wars (1940–1944)
In this sidebar to World War II, Finnish pilots used a mixed bag of aircraft from other nations including obsolete U.S. models with which they did well against the Russians (there is no data for the Russian side of this conflict). No less than 87 Finnish pilots were credited with at least five kills. The top three:

Eino Juutilainen, Finland, 94
Hans Wind, Finland, 78
Eino Luukkanen, Finland, 54

World War II (1939–1945)
Pilots from nations rapidly overrun often were able to join the Allies and thus fight for the war's duration—and run up higher scores. The French allowed pilots to include probable kills, unlike other nations. Russia provided the only female fighter aces—and by the end of the war more than 150 Russian pilots claimed scores of at least 20 (50 had 30 or more). Germany enjoyed more than 100 aces who gained more than 100 victories each (most from the Eastern Front)—and 35 had more than 200 each for the highest counts of aces in any war. Werner Mölders (Germany) was the first ace from any country to exceed 100 kills. Heinz Bär (Germany) became the first jet ace with 16 confirmed victories. Of Japanese pilots, nearly 140 claimed 10 or more victories. Only the top-tier aces from each country are included here.

Erich Hartmann, Germany, 352
Gerhard Barkhorn, Germany, 301
Gunther Rail, Germany, 275
Otto Kittel, Germany, 267
Walter Nowotny, Germany, 258
Hiroyoshi Nishizawa, Japan, 87
Tetsuzo Iwamoto, Japan, 80
Shoichi Sugita, Japan, 70
Saburo Sakai, Japan, 64
Ivan Kozhedub, Russia, 62
Aleksandr Pokryshkin, Russia, 59
Grigori Retchkalov, Russia, 58
Nikolai Gulaev, Russia, 57
Arsenii Vorozheikin, Russia, 52
Marmaduke Pattle, South Africa, 51
Richard Bong, U.S., 40
Thomas McGuire, U.S., 38
John E. Johnson, Britain, 38
David McCampbell, U.S., 34
Brendan Finucane, Ireland, 32
A. G. Malan, South Africa, 32
Franco Lucchini, Italy, 26
Adriano Visconti, Italy, 26
Marcel Albert, France, 23
Jean Demozay, France, 21
Stanislav Skalski, Poland, 21
Witold Urbanowicz, Poland, 20
Sven Heglund, Norway, 16

Korean War (1950–1953)
The Korean War included the first jet-versus-jet combat missions. By the end of the war, nearly 40 pilots flying the F-86 Sabre had become aces. Newly revealed records indicate that the Soviet Union claimed at least 44 aces.

Joseph McConnell Jr., U.S., 16
James Jabara, U.S., 15
Manuel Fernandez, U.S., 14
George A. Davis Jr., U.S., 14
Royal N. Baker, U.S., 13
Nikolay Sutigan, Soviet Union, 21
Evgenii Pepelyaev, Soviet Union, 20
Alexander Smorchkov, Soviet Union, 15
Lev Schukin, Soviet Union, 14
Dmitry Oskin, Soviet Union,15
Nikolay Dokashenko, Soviet Union, 14
Sergey Kramarenko, Soviet Union, 13

Vietnam War (1965–1973)
During the Vietnam War, several aces shot down their enemies using air-to-air missiles rather than gunfire, as in previous wars. The North Vietnamese claimed 17 aces.

Colonel Toon (Tomb), North Vietnam, 13+ (most probably a fictional character)
Nguyen Van Coc, 9
Mai Van Cuong, 8
Phan Thanh Ngan, 8
Nguyen Van Bay, North Vietnam, 7+
Charles DeBellevue, U.S., 6
Richard Ritchie, U.S., 5
Jeffrey Feinstein, U.S., 5
Randy Cunningham, U.S., 5
William Driscoll, U.S., 5
Robin Olds, U.S., 5, plus 12 in World War II (there has been no official confirmation on Olds's fifth victory)

Middle Eastern Wars
Israel has been very secretive about the men who became aces, but recent lists indicate at least 34, with Giorora Avan

(Epstein) leading the list with 17 victories. Egypt claims six aces, Syria five.

Indo-Pakistani Wars

In the Indo-Pakistani conflicts, Pakistan claims two aces, with Mohammad M. Alam having nine victories.

All over the world, scholars are busy reviewing claims, all of which are subject to argument over time. For the most part, the claims were made in good faith, most were confirmed, but in the confusion of battle mistakes were no doubt made.

Christopher H. Sterling

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Acosta, Bertrand B. (1895–1954)

Aviation pioneer. Born in San Diego, California, on 15 January 1895, Bertrand Blanchard "Bert" Acosta taught himself to fly and is thought to have built and flown his first airplane in 1910. He joined the Curtiss School of Aviation at San Diego's North Island as a mechanic in 1914 and became part of the instructional staff in 1915. Acosta spent much of the next two years at the Curtiss school in Ontario, Canada, training pilots for the Royal Flying Corps and the Royal Naval Air Service. After America declared war on Germany in April 1917, Acosta returned to the United States to teach Army pilot candidates at Mineola Field, on Long Island.

Following the war, Acosta helped establish the first airmail routes, took a Junkers transport airplane on a 60-city tour of the United States, and was both speed racer and endurance flier during the golden age of aviation. His contemporaries considered him one of the great natural fliers, and it was said that "he could put wings on a barn door and make it fly." In 1921, Acosta won the Pulitzer Trophy race flying at an average speed of 176.7 mph. According to the 1928 edition of *Who's Who in American Aeronautics,* he was the first American pilot to fly 200 mph.

In April 1927, he established an endurance record with copilot Clarence D. Chamberlin by remaining in the air without refueling for 51 hours. Between 12 and 14 April, Chamberlin and Acosta covered an estimated 4,100 miles, more than 500 miles farther than the distance from New York to Paris. Shortly thereafter, Acosta flew the Atlantic as part of a four-man crew led by the world-famous explorer, Richard E. Byrd. The crew may have reached Paris, but instrument problems and poor weather forced them to double back and ditch the plane in the ocean near the village of Ver-sur-Mer on 1 July 1927. Despite the inglorious finish and losing the transatlantic race to Charles Lindbergh by nearly two months, the crew received great international acclaim.

In November 1937, Acosta went to Spain to fly for the Loyalist cause. Flying obsolete bombers against targets protected by advanced German fighters proved a challenge, and the Acosta fliers did not receive the recognition and reward for their accomplishments they thought they deserved. Disillusioned, Acosta left Spain early in 1938. Poor health seems to have kept him grounded during World War II.

Acosta worked as a carpenter in a Catholic monastery in Garrison, New York, for a time in the early 1950s, and Admiral Byrd paid for Acosta, who was suffering from tuberculosis, to spend the last two years of his life at the Jewish Consumptives' Relief Sanatorium in Denver. Acosta died on 1 September 1954. His obituary in the *New York Times* noted that the veteran flier had been married twice and "was beset with troubles of various kinds throughout most of his adult life." Acosta's memory is perpetuated at the Portal of the Folded Wings, a shrine to early aviators in Los Angeles.

Bruce A. Ashcroft

See also

Curtiss, Glenn Hammond; Junkers Aircraft

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Ader, Clement (1841–1925)

French aviation pioneer born in Muret who carried out flight experiments in the late nineteenth century. Ader performed a brief, uncontrolled takeoff in one of his machines in 1890. Although ultimately unsuccessful in controlled flight (he claimed to have flown in 1897, but evidence is scarce), he remained interested in military aviation and wrote four books on its potential. The most important of those works was *L'aviation militaire* (1909), intended to teach officers about possible structures for an air force, multiple aircraft functions, and even the potential of an "aircraft carrier boat." (A year later, Eugene Ely performed the first takeoff from a ship.) Lacking the benefit of warfare experience at the turn of the century, few military thinkers initially paid close attention to Ader's published work, although it remains a classic in the development of air war thinking.

Guillaume de Syon

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Aerial Radio Navigation

Originated from Guglielmo Marconi's techniques of wireless telegraphy. Initially termed "wireless direction finding," aerial navigation has evolved from simple electronic devices and lighted airways to a sophisticated satellite system capable of determining the position of an aircraft to within a few feet. Navigational aids today are known by the generic acronym NAVAIDS.

The first attempts at ground-based aerial electronic navigation were German navy Zeppelins using a Telefunken compass. These terrestrially based navigation aids, or "rotating beacons," were used to guide the Zeppelins on their bombing raids to England. The Zeppelin's radio operator could determine the craft's position by triangulating between two or more ground stations. Although this technique worked well with the slow-moving Zeppelins, it proved impractical for faster, smaller aircraft.

In 1908, the U.S. National Bureau of Standards (NBS) began collaborating with both the U.S. Navy and U.S. Army on radio research, and by the beginning of World War I the NBS had become the focal point for studying communications and navigation technologies.

In July 1918, the U.S. Post Office approached the NBS for assistance in developing an electronic aeronautical navigation device for use in the newly formed Air Mail Service. But in 1921, the Post Office was forced to abandon its research because of budget cuts and renewed pressure to begin a transcontinental airmail service. Second Assistant Postmaster Otto Praeger now turned to the U.S. Army, which had earlier experimented with a system of towered, rotating lights for guiding pilots. This was the genesis of the lighted airway, and through the efforts of the Post Office it soon became the foundation for the first commercial airways.

The lighted airways worked well—but only in good weather. Although the Post Office focused its resources in the lighted airway system, it again began limited research in electronic NAVAIDS in 1925. The limited federal budget of 1925 continued to hinder the efforts of not only the Post Office but also the Army and the NBS as well. If air transport operations were limited to lighted airways that could be used only when the weather was good, then precise navigation required to support all-weather high-altitude flight would be impossible.

With Congress's passage of the Air Commerce Act of 1926, responsibility for the promotion of aviation, as well as the construction of an infrastructure to support all-weather flights, fell to the newly formed Bureau of Air Commerce within the Department of Commerce. The new law also charged the NBS with responsibility for the research and development of NAVAIDS. The earlier efforts of the Post Office, army, and NBS thus had laid the groundwork for the Low Frequency Radio Range, marker beacon, nondirectional beacon, and instrument landing system. A now properly funded NBS soon moved these NAVAIDS from the laboratory to a system of four-course, Low Frequency Radio Ranges that supported instrument flight.

The NBS continued to improve the Low Frequency Radio Ranges and through research overcame inherent problems such as night effect (the tendency for the signal to "wander" during night operations), as well as interference from other stations.

Continued research and development perfected the instrument landing system. Begun in the early 1930s, this system was in wide use after World War II. Problems associated with low-frequency navigation aids were soon overcome by developing NAVAIDS that broadcast on higher frequencies. The NBS was able to develop and begin fielding the Very High Frequency Omnidirectional Range Station (VOR) during the late 1940s. The VOR was a marked improvement over the Low Frequency Radio Ranges because it enabled pilots to select specific courses to or from navigation stations while overcoming problems associated with the Low Frequency Radio Ranges. The VOR and its military version (known as TACAN, for Tactical Air Navigation), as well as the hybrid system known as VORTAC have become the mainstay of aerial navigation in the United States and the world.

Randy Johnson

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Aerial Refueling

A tactic employed to extend the range, endurance, and payload of aircraft. Various stunts were performed in the United States in the 1920s to demonstrate aerial refueling's potential, and experiments by the RAF in the 1930s proved its feasibility. Aerial refueling was studied in World War II, but aircraft capabilities met wartime requirements. The Cold War prodded this technique into reality. U.S. bombers needed aerial refueling to reach targets around the world. Frequent demonstrations of this capability took place as the Strategic Air Command stood alert against Soviet forces.

The first aerial refueling system, developed in Britain by Sir Alan Cobham, utilized a hose and grapnel. The tanker and receiver aircraft rendezvoused with lines extended. Using the grapnels to hook the line and reel it in, the receiver could accept fuel. However, this required the receiver crew to retrieve the line and make the connections.

Single-seat aircraft became refuelable with the development of the probe-and-drogue system in 1949. The tanker would trail a hose while flying ahead of the receiver. The receiver, with a probe mounted on a wing or on the aircraft nose, would fly close enough to the tanker's hose to make contact. The connection was facilitated by a drogue—a basket to catch the probe—funneling it into the nozzle. This system remains the most popular worldwide, used by the U.S. Navy, Marines, NATO, and most air forces.

The U.S. Air Force uses the Boeing flying boom. This telescoping tube, affixed to the tanker's aft body, is used to mate the tanker and receiver. It transfers fuel much faster than the probe-and-drogue setup. General Curtis LeMay deemed this essential for refueling large aircraft, such as the B-52 bomber. Thus, the KC-135, with its flying boom, was selected in 1955 as the USAF's primary tanker. It remains in service today. Virtually all USAF strategic airlifters are air-refuelable. This global-reach capability enhances U.S. ability to project power worldwide.

The first combat air refueling took place on 6 July 1951, when a USAF KB-29 linked up with a flight of RF-80s over Korea. Refueling greatly extended the range of Japan-based fighters and reconnaissance aircraft in both Korea and Vietnam. Perhaps the most dramatic uses of aerial refueling have occurred in long-range strike missions. During the Vietnam War, aerial refueling enabled bombers based on Guam to hit targets in Vietnam. In the Falklands War, Vulcan tankers refueled bombers on transatlantic missions. U.S. bombing raids against Libya, Iraq, and Serbia launched from Britain and the United States would have been impossible without multiple aerial refuelings.

Aerial refueling is a force extender and a force multiplier. The U.S. deployment for the Gulf War, as well as later peacekeeping and contingency operations, were accelerated by the ability to move fighters and cargo aircraft rapidly using aerial refueling. Whether expediting humanitarian aid, providing loiter time to combat air patrols, or supporting strike missions halfway across the globe, aerial refueling has proven an invaluable resource.

Thirteen nations have this capability: Canada, China, France, Israel, Italy, Netherlands, Russia, Saudi Arabia, Singapore, Spain, Turkey, United Kingdom, and United States.

James M. Pfaff

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Aerial Torpedoes

The world's first precision-guided munitions. As early as April 1915, Elmer Sperry began developing unmanned flying bombs by combining his company's research on sea torpedoes and automatic flight control systems. Following the U.S. entry into World War I in 1917, Sperry received navy funding to accelerate development of his aerial torpedo—a remote-controlled aircraft for use against submarines. Employing gyroscopes for directional control, the world's first cruise missile flew approximately one-half mile without a human pilot on 6 March 1918. However, the early aerial torpedoes were crude and unreliable, resulting in cancellation of the Sperry project in January 1919. Thereafter, the navy's interest in aerial torpedoes shifted to torpedo-bombers.

During the interwar years, the U.S. Army contracted with Elmer's son Lawrence Sperry to continue its own wartime aerial torpedo project, the "Kettering Bug." By the early 1920s, an improved torpedo was making successful flights, but continuing problems with directional control forced Sperry to incorporate radio control for increased accuracy. In March 1922, a torpedo flew 63 miles and scored a direct hit on its target, but this success required 18 radio corrections from a chase aircraft.

General William "Billy" Mitchell was among the first Army Air Service officers to enthusiastically support the development of aerial torpedoes. In 1927, he foresaw the potential threat such weapons posed to England, and his 1930 book *Skyways* argued that offensive airpower would continue its advantage over ground and air defenses, as future bombers might launch aerial torpedoes from 100 miles away. However, insufficient funds led General Henry "Hap" Arnold to cancel the project in 1932 in favor of precision bombsight development and the emerging doctrine of daylight precision strategic bombing.

Paul G. Gillespie

See also
Precision-Guided Munitions

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Aeritalia

Italian aerospace industry formed in November 1969 by merging the private Fiat airframe business with the government-owned Aerfer (descended from Industrie Meccaniche e Aeronautiche Meridionali, or IMAM) and Salmoiraghi (a Milan instruments manufacturer); in 1976, Fiat sold its 50 percent share to IRI-Finmeccanica, which became sole owner. Because for decades Aeritalia had been the cable address of Fiat's Aeronautica d'Italia, the name had a significant history, but it also reflected the mandate to become the national industry leader. The company pursued a policy of international collaboration, as well as investment in the underdeveloped area of southern Italy.

In addition to building the F-104S fighter and G.91Y ground attack aircraft, the Turin combat aircraft division participated in the design and production of the Panavia Tornado and the early stages of Eurofighter development. Transport aircraft activity was concentrated in Naples, adding manufacture of the G.222 tactical airlifter (1970) to that of Douglas airliner structures inherited from Aerfer. Aeritalia joined the Boeing 767 program at inception, and in 1980 it formed (with Aérospatiale) a consortium to design and build the ATR turboprop commuter. The year 1981 proved crucial, bringing the first profits, acquisitions (conversion specialist Aeronavali, light aircraft manufacturer Partenavia, shareholdings in Aermacchi and RPV specialist Meteor), and the launch of the AMX attack aircraft, an Italian-Brazilian project that also involved Aermacchi and Embraer. In 1985, Aeritalia acquired aero-engine manufacturer Alfa Romeo Avio and, later, a 40 percent share in Piaggio.

A turning point in the gradual development of the Aeritalia space business was the European Space Agency's Spacelab, flown on STS-9 *Columbia* in November 1983. This led to work on other modules, including the U.S. Spacelab and European *Columbus.* In the launcher field, Aeritalia built the structures of the Alfa rocket for the Italian Ministry of Defense and then the liquid propellant tanks for Europe's Ariane missile. The company also built numerous satellites.

In December 1990, IRI-Finmeccanica merged Aeritalia with its radar and missile industry, Selenia, forming Alenia.

Gregory Alegi

See also
Aermacchi; Alenia; Breda; Eurofighter Typhoon; Fiat; Lockheed F-104 "Starfighter"; Panavia Tornado

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Aermacchi

Oldest Italian aircraft manufacturer in continuous existence. The company was founded as Nieuport-Macchi on 1 May 1913, after Giulio Macchi (1866–1935) and his French partners had already built their first aircraft for an Italian army competition.

In World War I, Nieuport-Macchi supplied one-fifth of all aircraft built in Italy, including the vast majority of fighters; indeed, it was an Ni.11 that on 7 April 1916 scored the first Italian air-to-air victory. After building the Ni.17, the company switched to the Hanriot HD.1, the standard Italian fighter at the time of the Armistice. In May 1915, Nieuport-Macchi was asked to copy a captured Lohner flying boat. This led to the establishment of a seaplane department, which quickly acquired autonomous design capabilities, immediately identified as "Macchi" types and epitomized by the M.5 (1916), the most widely produced flying-boat fighter of all time and the first that could best landplane fighters. Its successor, the M.7 (1918), would serve for 20 years.

Reflecting its maturity, the company in April 1924 became Aeronautica Macchi. By then, Mario Castoldi (1888–1968) had joined as chief designer. In the lean postwar years, Macchi employed around 200 people and lived on license production and small batches of its M.18 and M.24 military seaplanes. Invited to design the Italian competitor for the 1926 Schneider Trophy race, Macchi and Castoldi produced the winning M.39. Its M.52 (1927) and M.67

(1929) descendants were unsuccessful, but the C.72 (1931) broke the world speed record in 1934.

Macchi built some SIAI S.81 and S.79 bombers under license, in part at its new AUSA subsidiary, but the racing experience and the chairmanship of Paolo Foresio (1900–1980) had transformed it, as the 1936 fighter competition proved. The Fiat G.50 was already in production, but the C.200 (1937) was so superior that the Regia Aeronautica (the Italian air force) was forced to order it. Together with the C.202 (1940) and C.205 (1942) variants with German inline engines, and including those built under license by Breda and SAI Ambrosini, production ran to 2,600 aircraft, or one-fourth of the entire Italian World War II output.

In 1945, Castoldi was succeeded by Ermanno Bazzocchi (b. 1914). After some difficult years, Macchi settled upon a mix of license production (D.H. 100 Vampire jets, Fokker S.11 trainers, Lockheed CL-401s), overhauls (T-33s), and original designs. These included the MB.308 sportplane (1947) and especially the MB.326 jet trainer (1957), which would become the all-time Italian aviation export success and the first jet built in South Africa and Brazil, in addition to Australia. Its MB.339 derivative (1976) was adopted by the Italian air force, equipping (among other units) the Frecce Tricolori display team. It was sold in seven countries but lost the U.S. J-PATS competition it had entered in association with Lockheed.

In 1980, Aeronautica Macchi became the parent company of the new Aermacchi manufacturing subsidiary, a share in which was acquired by Aeritalia, then a partner in the Italian-Brazilian AMX attack aircraft program, which proved disappointing. To diversify, Aermacchi joined the Dornier Do.328 commuter program. In 1996, Aermacchi obtained from Agusta the SIAI Marchetti SF.260 and S.211 single-engine trainers, completing its range with the M-290 RediGO acquired from Valmet of Finland. Production was moved to Venegono airfield and the original Varese factory was sold. Aermacchi teamed with Yakovlev of Russia on a joint advanced trainer program but, after the experimental phase, decided to develop its own M-346.

In fall 2000, the Foresio family was negotiating the sale of its 75 percent share to Finmeccanica, the parent company of Alenia Aerospazio, with the stated purpose of making Aermacchi the training aircraft division of EADS, or the European Aeronautical Defense Systems. By 2002, these plans were on hold.

Gregory Alegi

See also

Aeritalia; Agusta; Alenia; Italian Air Force; Italian Aircraft Development; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II); SIAI Marchetti

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Aeroflot

Created by the Soviet Union as an instrument of national policy to provide affordable public transport for people and materials throughout the vast expanses of the Soviet empire; in this objective, it succeeded. In the course of steady expansion, after the teething troubles of the early years had been overcome, it became the largest airline in the world. Its domestic route network stretched across no less than 11 time zones—almost halfway round the globe.

Even before World War I (1914–1918), Russian aeronautical science was well advanced. With the Treaty of Rapallo, signed on 16 April 1922, the Soviets were able to take advantage of German technology. Junkers aircraft were assembled in Moscow, and a semblance of an air network took root.

On 1 May 1922, a joint Soviet-German airline, Deruluft, began services directly from Berlin to Moscow, using Fokker-Grulich F.III monoplanes. From 1 August to 25 September, flights were made between Moscow and Nizhne Novgorod by some Junkers F.13s on the occasion of the annual fair in the latter city.

On 9 February 1923, a national airline was organized when, by decree, the Red Air Force's Glavvozdykhoflot was charged with the establishment of an airline. The responsibility was soon transferred to Dobrolet (the All-Russian Volunteer Air Fleet), the direct ancestor of Aeroflot. The first scheduled services were on intercity routes in the soon-to-be-established Soviet socialist republics in Central Asia.

Dobrolet began to build a national network of air routes. In 1929, it had started air mail service from Moscow to Irkutsk, in central Siberia, a distance of almost 3,000 miles, followed by full passenger service in 1931. In 1930, Dobrolet took over the southern lines from Moscow to the Black Sea and the Caspian from Ukrvozdukhput, the Ukrainian airline based in Kharkov, which had started service in 1923. In the same year, it opened another isolated route in the Far East, as a branch from Khabarovsk, on the Trans-Siberian Railway, to Aleksandrovsk, on the island of Sakhalin. A link with Central Asia had been forged with a route from Moscow to Tashkent. Standard equipment at this time was the eight-seat Kalinin K-5, which had a marked resemblance to the Dornier Merkur.

By the early 1930s, the Soviet aircraft industry was beginning to establish itself. In July 1929, Mikhail Gromov (as revered in Russia as Lindbergh was in the United States) made his second goodwill tour of Europe with the ANT-9 Krylya Sovyetov (Wings of the Soviets).

In 1932, the Soviet Union consolidated its airline industry. Dobrolet became Aeroflot, which completed the trans-Siberian route in 1933, following the line of the famous railway but making the Moscow-Pacific journey in about three days instead of two weeks. By 1934, the airline had dispensed with foreign aircraft as Andrei Tupolev, preeminent among Russian designers, began to create workmanlike machines that did not break records but were adequate for the challenging task of coping with the Siberian climate. The four-engine ANT-6 was put into service with Aviaarktika, founded in 1930 specifically to develop aviation in the Arctic.

In June 1937, the single-engine Tupolev ANT-25 was used by Valery Chkalov and his crew, who flew nonstop over the North Pole from Moscow to Vancouver, Washington; a month later, not to be outdone, Gromov flew nonstop from Moscow to San Jacinto, California.

By 1940, the year the Soviet Union entered World War II, Aeroflot's route map was impressive, with many routes radiating from Moscow to link all Soviet major cities and industrial areas and venturing to a few points in eastern Europe. It had also taken over Deruluft, the jointly owned German-Soviet airline that since 1922 (following the signing of the Treaty of Rapallo) had linked Berlin with Moscow and St. Petersburg; ANT-9s were serving neutral Stockholm.

The wartime years saw the introduction of the ubiquitous Douglas DC-3, more than 6,000 of which were built under license as the Lisunov Li-2 in Tashkent.

The early postwar years saw a gradual recovery to peacetime conditions. Aeroflot did its best using indigenous designs and, rather like the British, had to start almost from scratch, as the war effort had demanded full concentration on military types. Two fine aircraft designers joined Andrei Tupolev in the commercial field. Sergei Ilyushin saw his Convair 240–like, 18-seat Ilyushin Il-12 go into service in 1946, with the improved 32-seat Il-14 following in 1954.

Another unheralded success was the Polikarpov U-2, a versatile performer, beloved among Soviet airmen as a trainer (rather like the U.S. Piper Cub or the British Tiger Moth) and used selectively by Aeroflot. One of the most versatile Aeroflot aircraft was the Antonov An-2, which made its first flight on 31 August 1947. This 12-seat biplane was at home on wheels, floats, or skis, could land and take off in about 100 meters, and was used by the thousands all over the Soviet Union, serving hundreds of communities from the Baltic Sea to the Bering Strait. Total production exceeded 20,000.

Aeroflot struggled along with the Il-14 as its flagship until the Soviet aircraft industry took the world by surprise on 22 March 1956, when a government delegation flew into London in a 50-seat Tupolev Tu-104 jet airliner. It entered service with Aeroflot on 15 September of that year, on the Moscow-Omsk-Irkutsk route, cutting the time from 18 hours to seven, and took its place in history as the first sustained airline jet service in the world.

The Soviet aircraft manufacturing industry shifted into high gear in 1957. The Ilyushin Il-18, the giant Tupolev Tu-114, and the Antonov An-10, all four-engined turboprops, entered service in that year. Aeroflot deployed them everywhere, and quite a few were exported. The An-10 became the standard equipment for the Arctic regions and started a Great Circle route from Moscow to Khabarovsk, via northern Siberia, in August 1960. In a similar way, Andrei Tupolev's Tu-114 was remarkable, being for several years the largest and longest-range airliner in the world. It was also the first Soviet-built airliner to be operated by a noncommunist airline, when Japan Air Lines used it for its Tokyo-Moscow service.

The Soviet solution to the long-range airliner was the Ilyushin Il-62, which was modeled on the British Vickers VC-10 and entered domestic service on 10 March 1967 and international service (to Canada) on 15 September. The direct Moscow–New York route, via Shannon and Gander, opened on 15 July 1968, and Aeroflot began to reach across the globe. Measured by passenger-kilometers flown, it was now, by a considerable margin, the largest airline in the world.

During the latter decades of the twentieth century, Aeroflot took its place among the flag-carrier airlines of the world and acquitted itself well. Its reputation for elegant service was not up to the standards of Western airlines, but Aeroflot's safety record, based on statistics rather than perception, was no worse than those of many Western airlines. The pilots and aircrews were proud and competent. They had to be: The airfields in Siberia were often potholed, and navigational aids across the endless taiga and tundra were few and far between.

Under the communist system, Aeroflot had no competition within the Soviet Union. It was the state airline, and so it enjoyed a monopoly as the transportation service of the entire country, and its aircraft provided all kinds of aerial work: crop-spraying, forestry and fishing patrols, ambulance and emergency services, and support in building oil pipelines, power lines, and railroads. Additionally, it was the air transport service for the Soviet armed forces, its role ranging from special flights for top brass to the transport of political prisoners to the labor camps of the Gulag.

By 1990, its route network was enormous. Almost 2,000 small communities in the Soviet Union were served by the ubiquitous An-2, backed up by the Czech Let L410 19-seat turboprop and the 32-seat Yakovlev Yak-40 trijet feederliner. Antonov An-24 twin turboprops were to be seen everywhere. On the main routes, Il-14s and Tu-104s had been replaced by 700 Tupolev Tu-134 twinjets and more than 1,000 Tu-154 trijets, the Soviet equivalents of the Douglas DC-9 and the Boeing 727, respectively. Aeroflot helicopters, ranging from the eight-seat Mil Mi-4 to the huge Mil Mi-26, with a payload of 20 tons, performed work of all kinds, from airlifts of electricity transmission towers to passenger service into remote Arctic villages where no airfields existed. Its freighter aircraft included the massive Antonov An-124, whose immense fuselage could swallow a Lockheed C-5A. Its wide-bodied 350-seat Ilyushin Il-86 passenger flagship had the unique convenience of a lower-level baggage compartment, enabling passengers to board and disembark far more quickly than on other jumbo jets. By 1991, when the transition from Soviet Union to the Commonwealth of Independent States took place, Aeroflot had almost 11,000 aircraft, including 3,000 An-2s and 3,400 helicopters. Staff numbers exceeded 600,000.

With the dissolution of the Soviet Union in 1991, the all-embracing Aeroflot was dismantled. Its assets in aircraft, installations, and staff were distributed among 32 local regions, and new, independent airlines were created in its place. Its fleet now reduced to 103 airliners, the aging giant was reduced to a shadow, retaining responsibility only for overseas and foreign routes. Relieved of the obligation to use Soviet-built (now Russian or Ukrainian) aircraft, Aeroflot turned to the West for more efficient equipment. On 24 January 1990, it confirmed an order for Airbus A310s. Service standards have visibly improved, and its safety record is no longer questioned. As it enters the twenty-first century, Aeroflot is now the aerial standard-bearer of the new Russia, a respected member of the worldwide fraternity of airlines.

R.E.G. Davies

See also

Tupolev Aircraft

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Aeronautica Nazionale Repubblicana (ANR)

Italian air service during World War II. After the Italian armistice in World War II, Germany formed the Repubblica Sociale Italiana (RSI; the Italian Social Republic) in territory still under Nazi control and reinstalled Mussolini as leader. The respected Colonel Ernesto Botto was appointed undersecretary for aeronautics of the unified Ministry of National Defense (later changed to Ministry of Armed Forces) and set out to form the Aeronautica Repubblicana (AR; the Republican Air Force). Many rallied to Botto's radio appeals to defend Italian skies, and manpower eventually rose to 15,000, including nonfliers who often joined solely to support their families or escape deportation to Germany. Eventually, the Germans allowed Botto to form, for each specialty, a group consisting of three operational squadrons and one training squadron, a communications regiment, an antiaircraft artillery organization, and a parachute regiment. In reality, the AR formed two fighter groups (which went into action against Allied bombers in January and April 1944), a torpedo-bomber group (March 1944), and a transport group (April 1944, which operated solely in Finland). Paratroopers fought as infantry on the Anzio front, but other flying units never became operational.

The AR operated gallantly under Luftflotte 2 (Second Air Force) control, albeit its effectiveness was limited by resources and the Nazis' grip on Italian industry, facilities, and manpower. Further problems arose from fascist attempts to politicize the AR, which caused Botto to resign in March 1944. He was replaced by General Arrigo Tessari, who obtained some Messerschmitt Bf 109 fighters from the Germans but was unable to change the Nazis' hostility. June 1944 saw the AR strike Gibraltar from southern France and change its name to the Aeronautica Nazionale (National) Repubblicana, but in August 1944 Luftflotte 2 attempted to incorporate it forcibly. When the Italians refused to swear oaths to Hitler and wear German uniforms, Mussolini interceded with Hitler, and Operation PHÖNIX was canceled.

Tessari was sacked with those who had assisted the Germans, and his place was taken by General Ruggero Bonomi. Unfortunately, the ANR had been gutted, and it was only in November 1944 that the 2d Fighter Group returned to combat, followed by the 1st Fighter Group in February 1945. Despite heavy losses, the two units fought until mid-April. The ANR disbanded or surrendered to the Allies in an orderly fashion, but on 29 April the 1st Fighter Group's beloved commander, Major Adriano Visconti, was summarily executed by communist partisans and instantly became a hero-martyr. All other ANR personnel were expelled from the Italian armed forces; some were readmitted during the Cold War.

Gregory Alegi

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Aeronautical Research Establishments

As politicians, military officials, and industrialists came to recognize the potential utility of airpower, aeronautical research establishments rose to advance aviation research and development. Large, well-financed research facilities were launched in most European nations and the United States as the military, industry, and academy converged to promote inquiry on the problems of flight.

France and Germany were early proponents of airpower. France centered aeronautical research first at the Aviation Science Institute, Athena Coustenis Observatorie, Meudon, and later at a special laboratory beneath the Eiffel Tower. In 1912, the German government and industry organized the German Aviation Fund to raise money for military aircraft. This fund supplied partial funding for the German Research Institute for Aviation, a civilian agency created as a central conduit for aeronautical investigation. This institute performed technical inquiries for the military and industry—though its civilian emphasis eroded as World War I approached. In 1916, the German War Ministry drew up plans for an extensive aeronautical research facility at Rechlin on Muritz Lake. In 1918, Rechlin became the chief aeronautical experiment station and testing site for the German Army. The Treaty of Versailles forbade Germany an air force, but testing and research continued at Rechlin under the auspices of the Rapallo Treaty. When Hitler created the Luftwaffe in 1935, Rechlin became the chief experimental facility for the Reich Air Ministry. Rechlin continued in this capacity throughout the 1930s and World War II, contributing much to the development of the Luftwaffe. Badly bombed in the final days of the war, Rechlin's once extensive facilities were virtually wiped out at war's end. Today an aeronautical museum sits on the site.

The United States and Great Britain followed their French and German counterparts in building aeronautical research establishments. Aviation inquiry in the United States received impetus in 1915 when Congress established the National Advisory Committee for Aeronautics (NACA) to correct America's deficiencies in aviation. NACA's enabling legislation offered the possibility of an aeronautical research laboratory, and in 1916 Congress appropriated $85,000 for that purpose. In 1920, Langley Memorial Aeronautical Laboratory, NACA's first research facility, was formally dedicated. Langley allowed NACA to abandon its previous policymaking role and concentrate on research. NACA expanded Langley's facilities and subsequently opened two additional laboratories: the Ames Aeronautical Laboratory and the Flight Propulsion Research Laboratory.

Britain's interest in airpower began as early as 1892, when the War Office created a balloon factory to design and build dirigibles. As interest in dirigibles waned, the factory changed its emphasis and, after moving to Farnborough in 1912, became the Royal Aircraft Factory. In 1916, the British government decided to transfer design and manufacture of aircraft to industry, confining Farnborough to research. In 1918, the War Ministry renamed it the Royal Aircraft Establishment (RAE) to avoid confusion with RAF, the acronym for the Royal Air Force. The RAE would remain Britain's chief aeronautical research facility for the reminder of the century.

In the space age, research establishments have continued to explore new frontiers in flight. France has centered its research at the Office National d'Etudes et de Recherches Aerospatiales, a public institution responsible to the French Ministry of Defense. In reunified Germany, the German Aerospace Center has sustained a long tradition of aviation research and development. The U.S. National Aeronautics and Space Administration (NASA), NACA's successor, has expanded research at Langley, Ames, and other research facilities around the country. The establishment at Farnborough has undergone various name changes in response to developments and changing research agendas. In 1988, it became the Royal Aerospace Establishment; in 1991, the Defense Research Agency; and in 1995, the Defense Evaluation and Research Agency. Farnborough retained its military emphasis throughout the years, but in the wake of declining military research in the late 1990s the Labor Government decided to divest itself of the facility and shift it to civilian purposes—a move that drew the ire of the Conservative Party and press. The Ministry of Defense selected TAG Aviation to operate the facility when it shifted from military to civilian operations in 2001.

Daniel E. Worthington

See also

Balloons; British Aerospace; German Air Force (Luftwaffe); National Advisory Committee for Aeronautics; National Aeronautics and Space Administration; Wind Tunnels; World War I Aviation; World War II Aviation

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Afghanistan War (1978–1992)

The 1978–1992 war started after Afghan communists took power in April 1978 and established the Democratic Republic of Afghanistan (DRA). The air force—organized and equipped along Soviet lines since the 1950s—failed to defeat widespread Islamic guerrillas supported by Pakistan and, eventually, the United States.

In 1979, the Soviets sent advisers and helicopters to help the DRA. In December 1979, the Soviets invaded Afghanistan, making extensive use of transport aircraft to airlift forces, replacing failed communist leaders with a pro-Moscow leader. Strong Soviet ground and air forces were then involved in a bitter guerrilla war from 1979 to 1989.

Soviet and DRA helicopters proved vital for air assaults, tactical mobility, and firepower. Much use was made of fighter-bombers, creating immense refugee flows, plus high-altitude bombing by strategic bombers and converted transports. Transport aircraft provided resupply from the Soviet Union.

The Afghan resistance had minimal air defenses until extensive aid arrived from the United States (and other friendly countries). One stronghold, the Panjshir Valley, was defended by only 13 heavy machine guns in 1982 but more than 200 by 1984. The resistance had no aircraft. The only air combat occurred during Soviet and DRA air strikes on proresistance Pakistani forces during 1984–1987. Twelve aircraft were shot down by Pakistan. One Pakistani F-16 was lost to friendly fire. The resistance had a few Soviet-designed SA-7 man-portable SAMs until 1986. Then, U.S.-designed Stinger SAMs were supplied. Although high Stinger claims were not borne out postwar, its dozens of kills still had a tremendous impact.

Political change in the Soviet Union led to withdrawal of combat forces in 1989. Soviet combat losses for 1979–1989 were 118 airplanes and 333 helicopters, the DRA 111 airplanes and 160 helicopters. In 1989, the Afghan air force that the Soviets had built up helped repulse resistance attacks, especially at Jalalabad. They were supported by a large-scale Soviet resupply airlift, which continued until the end of 1991. The pro-Moscow regime fell in April 1992.

David C. Isby

See also

Counterinsurgency Operations; Mil Aircraft

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Agusta

Italian helicopter manufacturer. Giovanni Agusta (1879–1927) flew a biplane glider in Capua in 1910. A foreman and inspector with Caproni during World War I, after the Armistice Agusta established in Libya an aircraft overhaul business (although the firm was incorporated only in May 1953). Returning to Italy, in 1924 Agusta built a hangar at Cascina Costa (near Varese) on land leased from the Regia Aeronautica (the Italian air force). Activity focused on maintenance and the manufacture of spares, but several motor-glider prototypes were built. The first series production was an order for Romano Ro.41 biplanes under license, the company's first series production. In World War II Agusta continued to overhaul aircraft and build Ro.41 and Avia FL.3 trainers.

In 1952, Agusta agreed to build the Bell 47 helicopter under license. The first Agusta-Bell (AB) 47 flew in May 1954 and was followed by more than 1,000 production models. Large quantities of the entire Bell range were built, including the AB.204, .205, .206, .212, and .412. Augusta production included the Sikorsky H-3/S-61 family and the Boeing CH-47.

To cope with demand, the firm subcontracted airframe work to neighboring SIAI Marchetti, which Agusta bought in 1973. Agusta gradually established its design capability, and after some experimental types, the advanced A.109 (1971) was put into production, some 700 being built by 2001. At its 1985 peak, Agusta employed about 10,000 people in three divisions—helicopters (accounting for 76 percent of sales), airplanes (21 percent), and aerospace systems (2 percent).

Agusta was acquired in 2001 by IRI-Finmeccanica, cutting its workforce to 6,000. Agusta launched the BA.609 tiltrotor and AB.139 tactical helicopter with Bell. A merger with Westland was announced in summer 2000 and received antitrust approval in November.

Gregory Alegi

See also

Bell Aircraft; Boeing-Vertol CH-47 "Chinook"; Breda; Caproni Aircraft; Helicopters, Military Use; SIAI Marchetti

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Aichi Aircraft

Aichi Tokei Denki K.K. (Aichi Clock and Electric Company Ltd.), the fourth largest aircraft manufacturer in Japan during World War II. Aichi entered into the industry in 1920 when it began making airframes and expanded in 1927 when Aichi began building engines.

Aichi had four primary aircraft that it produced. The D3A, which carried the Allied code name "Val," was a fixed-gear dive-bomber that sank more Allied fighting ships than any other Axis aircraft. The Val was most famous for its devastating role at Pearl Harbor. Although the plane's technology was outdated by war's end, it was still in service with many units and as a kamikaze weapon.

The D4Y Suisei (Allied code name "Judy") was designed by Yokosuka Aircraft but was mass-produced by Aichi. Its original role was to replace the Val in its dive-bombing duties, but it evolved into the role of reconnaissance and night interception. The Judy first saw combat in February 1944 at Truk Island. Late in the war the Judy was also used as a kamikaze weapon.

Aichi's E16A Zuiun floatplane (Allied code name "Paul") was originally designed as a reconnaissance aircraft but evolved into a dive-bomber.

The B7A Ryusei (Allied code name "Grace") was Aichi's torpedo-bomber. The aircraft was unique for the Japanese Imperial Navy, for it sported a gull-wing design. Production of the Grace was devastated in May 1945 when an earthquake hit the Tokai district in Japan. At war's end only about 100 B7As had been produced.

David A. Pluth

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Air America

Airline secretly owned by the U.S. Central Intelligence Agency (CIA). The airline's roots date to 1950, when the CIA purchased the assets of Civil Air Transport (CAT), an airline that had been started in China after World War II by General Claire L. Chennault. CAT continued to fly commercial routes throughout Asia, acting as a privately owned commercial airline. At the same time, under the corporate guise of CAT Inc., it provided airplanes and crews for secret intelligence operations. By the summer of 1970, the airline had almost 50 twin-engine transports, short takeoff and landing aircraft, and 30 helicopters dedicated to operations in Laos.

Air America crews transported tens of thousands of troops and refugees. They flew nighttime airdrop missions over the Ho Chi Minh Trail and engaged in numerous clandestine operations. Without Air America's presence, the CIA's effort in Laos could not have been sustained. In January 1961, Air America delivered weapons to the first 300 trainees.

With authorization to arm and train 1,000 Hmoung tribesmen as a test of the concept, CIA station chief James W. "Bill" Lair visited Vang Pao and arranged for an arms drop at Pa Dong, the famous mountaintop base south of the Plain of Jars. During the war in Laos, Air America was called upon to perform paramilitary tasks at great risk to the aircrews involved. Some Air America pilots flew in Laos for more than a decade, braving enemy fire and surmounting challenging operational conditions with rare skill and determination. As pointed out by a senior agency official during the dedication of a plaque to Air America personnel at CIA Headquarters in May 1988: "The aircrew, maintenance, and other professional aviation skills they applied on our behalf were extraordinary. But, above all, they brought a dedication to our mission and the highest standards of personal courage in the conduct of that mission."

In April 1972, CIA Director Richard Helms ended a lengthy debate within the CIA over the continued need for a covert airlift capability, and he ordered the agency to divest itself of ownership and control of Air America and related companies. Air America would be retained only until the end of the war in Southeast Asia.

Henry M. Holden

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Air Commandos

The 1st Air Commando Group (ACG) achieved several military "firsts" in the jungles of Asia while more glamorous campaigns in Europe captured headlines during World War II. Japan invaded Burma on 23 December 1941 to cut off Allied supplies between India and China, to use Burma as a wedge to strike into China and India, and as a buffer to protect Japan's conquests of Thailand, French Indochina, and China.

Burma's rail and road development was minimal; rivers were the major means of transport. The region's mountains, rivers, jungles, insects, and drenching monsoons posed a problem for invaders and British forces in Burma were minimal, trusting in topography and climate to aid their defense. Burma command was placed under General Archibald Wavell, commander of British forces in India, on 12 December 1941. When Chiang Kai-shek offered Chinese armies, a dubious Wavell accepted, because with the help came Claire L. Chennault's American Volunteer Group, the famous Flying Tigers.

Singapore fell on 15 February 1942, giving Japan access to the Malay Peninsula. General Sir Harold Alexander abandoned Rangoon on 8 March 1942, cutting off support for Allied defenders in Burma. British Major General William J. Slim left more than half of his army, not trained for jungle warfare, in Burma and escaped with 12,000 men, reaching India on 16 May 1942. U.S. Lieutenant General Joseph W. Stilwell, seeking to defend the Mandalay railway, led a Chinese army into Burma that broke in the face of the enemy. Without rail or road, Stilwell trekked into Imphal, India, three days later.

In March 1942, British Colonel Orde C. Wingate noted that Japan had light concentrations of lesser-trained troops in Burma's interior. He proposed Long-Range Penetration (LRP)—a commando force placed behind Japanese lines. LRP would create confusion in enemy areas, cutting off supplies and communications to weaken coordination of enemy campaigns. At the Quebec Conference in 1943, U.S. President Franklin D. Roosevelt and British Prime Minister Winston Churchill endorsed Wingate's strategy and urged U.S. Army Air Forces General Henry H. "Hap" Arnold to develop a plan. Arnold wrote: "We visualized an air commando force, the first in military history. Large numbers of Allied ground troops would be conveyed by aircraft deep into Burma, and once there they would be supplied wholly by air. General Wingate believed that, while the Japanese were excellent jungle fighters, well-trained Allied troops could defeat them at their own game, provided they were mobile, in sufficient force, and exploited the military value of surprise."

On 26 August 1943, British Admiral Lord Louis Mountbatten and Arnold proposed an experiment in aerial warfare: a highly mobile LRP force, complete with its own transportation and services. It was code-named Project Nine, and Arnold found resourceful leaders in Lieutenant Colonel Phillip G. Cochran, who had distinguished himself leading a P-40 squadron in North Africa, and Lieutenant Colonel John R. Alison, well experienced in the P-40 in China with Chennault.

In December 1943, Project Nine, renamed the 5318th Provisional Unit, equipped with Sikorsky YR4 helicopters, L-5 and L-1 light planes, B-25s, P-51s, Noorduyn C-64s, Waco CG4A gliders, and C-47s, began training with Wingate's Special Force. On 5 March 1944, Operation THURSDAY was launched. C-47s towed gliders from India, more than 200 miles over 7,000-foot mountains, to land 539 men, three pack mules, and almost 33 tons of equipment, including a bulldozer, at "Broadway," 165 miles inside Japanese lines. Only 37 of the 52 gliders made it; the force lost 31 killed and 40 wounded to crashes. Without enemy resistance, a runway was graded and used by C-47s and P-51s to attack Japanese airfields, provide supplies and close air support for Wingate's forces, and disrupt enemy transport and communications.

On 24 March Wingate was killed in an air crash; five days later the unit was officially named the 1st Air Commando Group. By May 1944, monsoons made aerial supply impossible, the 1st ACG and the Special Forces troops were fatigued, and the unit was withdrawn and reorganized. The bomber section was eliminated, troop carrier squadrons were added to transport Chinese troops and supply China, and new P-47s allowed operations to resume. Success led to a 2d and 3d ACG composed of fighter squadrons, aircraft maintenance, personnel support facilities, medical detachments, and troop carrier squadrons of C-47s and gliders. The 2d ACG arrived in India in December 1944. The 3d ACG went to the Philippines in late 1944 and flew missions to Formosa and the China coast before moving to Japan in October 1945. All ACGs were disbanded by 1948.

Richard C. DeAngelis

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Air (Aerospace) Defense Command (ADC)

Major U.S. Air Force command responsible for the air defense of the United States. The first command with this name was established as a small planning headquarters on 26 February 1940, but it was disbanded in June 1941. ADC was revived on 21 March 1946 as one of the three central USAF combat commands of the Cold War, along with Strategic Air Command (SAC) and Tactical Air Command (TAC). ADC and TAC were soon overshadowed by SAC and sorely lacked for funding; as a result, in November 1948 both were folded into the newly created Continental Air Command (CONAC). ADC continued only as a planning command within CONAC and was abolished altogether in July 1950. In January 1951, however, in the wake of the first Soviet atomic test and massive increases in U.S. defense spending, ADC was reestablished as a major command. Cooperation with the Canadian armed forces, already close since the establishment of the Permanent Joint Board on Defense in August 1940, grew even closer in 1951 with the appointment of Royal Canadian Air Force liaison officers to ADC headquarters.

During its heyday in the 1950s and early 1960s, ADC rapidly expanded in resources and influence as it attempted to keep pace with the growth of the Soviet strategic nuclear threat. At its height in the late 1950s, ADC's budget rivaled that of SAC, with ADC's 250,000 personnel exercising control over air defenses that included more than 2,000 fighter-interceptors and several different series of radar installations that sprawled from Alaska to Greenland. To coordinate the air defense activities of the other services, in September 1954 ADC was subordinated to the newly created joint Continental Air Defense Command (CONAD). This closer interservice cooperation was soon followed by closer international cooperation with the creation in September 1957 of North American Air Defense Command (NORAD) and its system of joint command of U.S. and Canadian air defenses.

After the first Soviet ICBM tests of 1957, fears of a "bomber gap" were soon replaced by fears of a "missile gap," which threatened to make many of ADC's weapons systems obsolete just as they were coming on line. As the major component force of both CONAD and NORAD, ADC gradually shifted its emphasis from antiaircraft defense to antimissile warning and defense, a change recognized in 1968 by its designation as the Aerospace Defense Command. Throughout the 1970s, most of its air defense missions were transferred to units of the Air Force Reserve and the Air National Guard, and in March 1980 ADC was disbanded, its remaining units divided among TAC and SAC.

David Rezelman

See also

Antimissile Defense; Ballistic Missile Early Warning System; Cold War; Continental Air Command; Distant Early Warning; North American Air Defense Command; SAGE Defense System; Sputnik; Strategic Air Command; Tactical Air Command

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Air Interdiction (AI)

The delay, disruption, or destruction of enemy forces or supplies en route to the battle area. A distinction is often made between strategic and tactical interdiction. The former refers to operations whose effects are broad and long-term; tactical operations are designed to affect events rapidly and in a localized area.

AI is a core airpower mission that has been conducted since World War I by virtually all air forces. In that war, the goal was to isolate the battlefield by strafing and bombing enemy supply lines. Favorite targets were railroad lines, bridges, and truck convoys. Due to the primitive state of aircraft and weapons technology, as well as the undeveloped nature of air doctrine and tactics, AI missions in World War I were of limited utility.

The potential of AI was clearly recognized, however, and during World War II it once again became a major mission of air forces. Although AI operations were conducted in all theaters, the most extensive and thoroughly analyzed were those of the United States and United Kingdom against the Axis. Specifically, the Allies launched major AI efforts in the North African, Italian, and Normandy campaigns. The venues for these three campaigns were markedly different in terms of weather, terrain, the enemy's supply and transportation infrastructure, and the availability of intelligence regarding the enemy. As a consequence of these differences, the results of AI also varied. The greatest success was in the desert terrain of North Africa, where Axis forces also relied heavily on vulnerable and visible sea convoys across the Mediterranean Sea. The Italian campaign, by contrast, was characterized by mountainous terrain, poor weather conditions, and shortened German supply lines. The diverse results of these two campaigns taught air planners differing lessons.

AI has continued to play a major role in conflicts since World War II. It was used extensively in U.S. conflicts in Korea, Vietnam, Iraq, and Serbia, as well as in wars between Israel and the Arab states in the Middle East. Once again, differing local conditions and political restraints have had an enormous effect on how AI was conducted and the degree to which it was successful. In Vietnam, for example, the strategic interdiction campaign known as ROLLING THUNDER (1965–1968) was largely unsuccessful. The dense jungle terrain, poor intelligence on enemy movements, and political restrictions on targets struck made U.S. AI efforts largely futile. The flow of supplies and reinforcements from North Vietnam to their units in South Vietnam was not seriously affected. In contrast, Coalition AI efforts in the Gulf War (1991) were extremely successful in isolating front-line Iraqi units from their bases in the rear. Intelligence, much of it derived from space and airborne sensors, gave an unusually clear picture of enemy locations, and the open desert terrain similarly facilitated AI operations.

When assessing AI efforts over the past century, it is possible to identify several factors that will have an impact on success. First, air superiority is essential for AI because it permits a more thorough identification and attack of enemy forces and supplies while also exposing the attacking aircraft to less risk. Second, intelligence regarding enemy dispositions, movements, stockpiles, and intentions is crucial. In the North African campaign, for example, "Ultra" intelligence sources gave the Allies a clear picture of Axis shipping in the Mediterranean. In contrast, in Vietnam the United States had a very poor understanding of Vietcong and North Vietnamese activities. Third, weather and terrain will have a major impact on AI's success or failure. One factor included

The Lockheed Martin F-16s of the Air National Guard have taken on a prominence in American skies since the terrorist strike of 11 September 2001. This Fighting Falcon of the 174th Tactical Fighter Wing is truly a part of the "Total Force" of U.S. air power. (U.S. Air Force)

here is the ability to conduct AI at night or in marginal weather—conditions that assist the clandestine movement of forces and supplies. Fourth, AI operations must be persistent. If an enemy is allowed a respite, it will resupply and stockpile, making the AI effort ineffective. Fifth, air planners must have realistic objectives. It is virtually impossible to totally isolate the battle area—something will always get through, and that amount may be enough to sustain the enemy. For example, even if 95 percent of all supplies to Axis forces in Italy during World War II had been stopped—an impressive feat—there would still have been enough matériel getting through for Axis forces to conduct effective defensive operations. The sixth factor is related and is perhaps the most important: There is a symbiotic relationship between air and surface forces in a successful AI campaign. An enemy that is quiescent and stationary consumes few resources while also presenting few targets. If, by contrast, enemy forces are attacked and flushed from their defensive positions by friendly surface forces, they will consume far more resources, especially fuel and ammunition, while also exposing themselves to air attack.

AI will continue to be an important mission in future conflicts, and it will continue to evolve in character. Enemy forces can be expected to become increasingly adept at camouflage, deception, hardening, air defense, and the use of decoys. Air forces, however, have new air- and space-based sensors, as well as increasingly effective munitions, which make it easier to locate and destroy enemy forces and supplies.

Phillip S. Meilinger

See also

Missiles, Air-to-Air; ROLLING THUNDER; STRANGLE; Tactical Air Warfare

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Air National Guard (ANG)

U.S. service arm that claims a heritage dating to the states' flying squadrons between the world wars, but its official existence dates to defense reorganization in 1947. Under the National Guard Bureau, it is a state organization with a federal mission and U.S. Air Force funding, training, organization, and equipment. In peacetime, it provides humanitarian and disaster assistance under state control; its units are subject to activation in national emergency.

Air Force leaders accepted the ANG due to the political influence of its backers, then left it marginally competent, poorly trained, and poorly equipped, the playground of the "weekend warrior." Mobilization for the Korean War in 1950 was a fiasco, forcing the Air Force to upgrade the ANG's quality in the 1950s. Under President Dwight Eisenhower's New Look, the guard gradually became a competent if limited force. The Berlin crisis of 1961 demonstrated that the ANG was still inferior to the regular Air Force, unready for combat.

In the 1960s the Air Force attempted to desegregate its ANG elements, and it controlled the ANG only when it activated. There was no way of forcing the state units to integrate against their will. Only after the Civil Rights Act of 1964 did the first halting steps begin. In the 1970s the ANG integrated.

The turning point came in 1968. To placate the South Koreans, who feared an invasion after the *Pueblo* crisis, President Lyndon Johnson sent 350 Air Force planes and mobilized 14,000 reservists. After the Tet Offensive, the politically cautious Johnson mobilized 22,000 more for service in Vietnam. The ANG units were combat-ready or became deployable within a month of activation and from June 1968 through April 1969 flew 24,124 sorties and 38,614 combat hours at a cost of seven pilots, one intelligence officer, and 14 planes. The ANG demonstrated competence equal to the regulars.

The guard performance in 1968–1969 allowed a switch to Melvin R. Laird's total force policy in 1970. The ANG enjoyed modern equipment, training, and near equality with the regulars. Over the next two decades, the ANG slowly assumed primary missions once dominated by regulars. DESERT STORM and other Air Force operations depended on the ANG.

John Barnhill

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Air Rescue

Air rescue, specifically combat air rescue, dates back to before World War II when the German Luftwaffe established the Seenotdienst, its equivalent of an air rescue service. The Germans converted a small number of Heinkel 59 (He 59) biplane floatplanes and incorporated rescue boats for service in the Seenotdienst. During World War II, both England and the United States established dedicated air-sea rescue units, but it was the Germans who first pioneered what would become known as combat search and rescue (SAR) to include using dedicated rescue aircraft and boats as well as incorporating fighter planes as escorts.

Before the Battle of Britain, rescue aircraft were treated as sanitary vehicles, or "flying ambulances." But in 1940, British Prime Minister Winston Churchill ordered Seenotdienst aircraft shot down when it was discovered the Germans were using them for reconnaissance as well as aircrew recovery. Since then, combat aircrew recovery vehicles have been fair game.

Although Germany led the way in developing air rescue, the U.S. Army Air Forces soon caught up. Rescue versions of the B-17 and B-29, designated the SB-17 and SB-29, were used to drop life rafts and even laminated mahogany boats to downed crews. Before the war's end, 0A-10 Catalina flying boats and Sikorsky R-4 and R-6 helicopters were used, the latter being credited with saving 43 airmen from the jungles of Indochina and Burma.

During the Korean War, the U.S. Air Force added Sikorsky H-5s and, later, much more capable H-19s to the inventory of the Air Rescue Service. These aircraft, escorted by North American F-51 Mustangs and working in conjunction with SA-16 twin-engine amphibians, picked up 170 U.S. Air Force, Navy, and Marine aviators along with 84 Allied airmen. Among those rescued was Captain Joseph C. McConnell Jr., who would go on to become the leading ace of the Vietnam War.

It was during the Vietnam War that the Search and Rescue Task Force (SARTAF) came of age. Helicopters, a rescue control aircraft, dedicated fighter escorts, and forward air control aircraft all worked as part of a team with specially assigned tasks and tactics developed to cover a variety of situations.

During the Vietnam War, the introduction of air-refuelable Sikorsky HH-3Es in 1965, as well as the longer-range, more capable HH-53 in 1967, revolutionized aircrew recovery. SARTAF evolved from using Douglas HC-54s to Lockheed HC-130s capable of performing both the command and control and air refueling tasks. Throughout the war, the most reliable rescue escort fighter was the venerable Douglas A-1 Skyraider (operating under the call sign "Spad"). Although the composition of SARTAF changed as the war dragged on, with A-1s being replaced by Vought A-7s toward the end of the conflict, the basic elements and mission remained the same. By the time the war ended in April 1975, the Aerospace Rescue and Recovery Service (ARRS) was credited with saving 3,888 lives, of which 2,870 were U.S. military personnel. Combat aircrew recovery missions ranged all over the theater, even to the suburbs of the enemy capital; in October 1970, ARRS crews ferried Special Forces teams in a failed attempt to rescue POWs confined in the infamous Son Tay prison some 26 miles north of downtown Hanoi.

Today, combat SAR capabilities are resident in the Special Operations Command and the Air Force's reserve components. Their duties range from plucking hapless crews from sinking vessels, to darting deep into Bosnia and Serbia to rescue downed airmen, to flying combat rescue air patrol for ongoing operations in the Middle East. As the U.S. Air Force enters the twenty-first century, the men and women of the Aerospace Rescue and Recovery Service continue in their heroic tradition "that others may live."

Earl H. Tilford Jr.

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Air Superiority

Generally defined as the degree of air dominance that gives one force the ability to conduct air operations over the forces and territory of another while denying that same ability to the enemy.

It was realized early on during World War I that air superiority increasingly was a necessity for successful military operations on land, at sea, and in the air. In fact, the first military air mission was observation—the reconnaissance of enemy territory. In order to mask operations and maintain secrecy, however, it was necessary to prevent enemy reconnaissance. This led quickly to air-to-air combat and the quest for air superiority.

The battle for air superiority became a long and costly process during World War II but, to a great extent, determined the outcome of battles, campaigns, and even the war. Clearly, the Battle of Britain saved the British from German invasion. When the Germans and Japanese eventually lost control of their own skies, they suffered tremendous disadvantages and casualties as a result. Air superiority has been a factor in all conflicts since World War II, although it is also apparent that air superiority is of less utility in an unconventional or guerrilla war.

It is important to remember the two components of air superiority: to deny the enemy air operations while also conducting them yourself. In order for air forces to be truly effective, both conditions are necessary. This dual nature means that a potential adversary need not build a modern air force to contest the sky; it merely needs to build a capable ground-based air defense system to prevent airpower being used against him. Because the West, and especially the United States, relies heavily on airpower to achieve its objectives, this is a significant concern.

Another issue often discussed is whether air superiority is required at the theater level or simply at the local level where other military operations are occurring. These two concepts would require significantly different forces and doctrines for their implementation. The United States especially has generally opted for the former and attempted to gain air superiority over an entire theater. Indeed, U.S. military leaders believe that having the initiative is crucial and that the air superiority battle is best fought over the enemy's territory rather than over one's own. Similarly, the geographical situation can play a determining role in how and where the air battle will be fought. For example, the United States—protected by two oceans—has never had to contend for air superiority over its own territory; by contrast, Germany—with hostile powers on its borders—had a far more immediate problem in controlling its skies during both world wars.

The method used to gain air superiority is variable and to a great extent depends on the targets chosen. Typical candidates for attack are the aircraft themselves—either in the air or on the ground—air bases, aircrew members, command and control facilities, radar networks, aircraft/engine factories, and fuel supplies.

Air superiority is likely to remain a key requirement for twenty-first-century military operations. The extension of military operations into space will require enhanced technology and employment concepts to ensure space superiority as well.

Phillip S. Meilinger

See also

Air Defense Command; Airborne Early Warning; Britain, Battle of; Defense Suppression; MiG Alley; Missiles, Air-to-Air

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Air Technical Intelligence

As Europe marched toward war early in the twentieth century, the industrial nations raced to develop advanced aircraft. American aviation, isolated from the war geographically and politically, lagged behind technologically, industrially, and militarily. Major General George O. Squier, head of the Aviation Section of the U.S. Army Signal Corps, forerunner to today's U.S. Air Force, invited engineers from England, France, and Italy to visit the United States. In turn, more than 100 American engineers and military planners under the direction of Colonel Raynal C. Bolling traveled to Europe in June 1917 to investigate European technology.

In July of that year, the first foreign aircraft, a British de Havilland D.H. 4, arrived in New York for study. In October, the Army Signal Corps selected a site north of Dayton, Ohio, at which to build an aviation engineering and testing center—McCook Field. The D.H. 4 also moved to Dayton, where it was used as a pattern for the manufacture of the aircraft, outfitted with American-made machine guns, instruments, and a Liberty engine. When produced in the United States, it was designated the DH-4.

The field's missions included the evaluation of foreign scientific and technical programs related to aircraft—the bedrock of air technical intelligence (ATI). Early work focused on copying or modifying foreign aircraft for American industry; in time, the Foreign Data Section acted as a clearinghouse for information internally to the U.S. Army's Airplane Engineering Department and externally to American business, education, and military organizations. The unit also translated foreign documents into English. Following the war, the Armistice with Germany brought 347 aircraft to the United States for study and as war relics. In addition, the technical intelligence agency acquired British, French, and Italian airplanes and a collection of engines, machine guns and aerial cannons, navigation equipment, parachutes, and aircraft manufacturing machinery. In 1927, the missions at McCook Field moved across town to Wright Field.

During the 1930s, European and Japanese aircraft industries surpassed U.S. industries. With the commencement of World War II, the ATI function at Wright Field grew from fewer than 100 people in July 1941 to nearly 750 by December 1945. Front-line troops sent back captured enemy equipment to Wright Field for assessment. The first German and Japanese aircraft arrived in 1943, and captured equipment soon filled six buildings, a large outdoor storage area, and part of a flight line hangar. One early ATI program involved the collection of factory markings and nameplates, which resulted in the intensive bombing efforts against German ball-bearing plants in 1943. Data collected from the nameplates from some 1,000 Japanese aircraft provided one of the best sources of target data for manufacturing plants on the home islands of Japan.

The most famous World War II ATI missions in Europe were Project Lusty and Operation PAPERCLIP. Project Lusty brought fame to Colonel Harold E. Watson, twice commander of the Air Force's Air Technical Intelligence Center. Watson and a group of handpicked pilots (known as "Watson's Whizzers") gathered German aircraft from the battlefield and sent them back to Wright Field for study. The best known of these aircraft was the Messerschmitt Me 262 jet fighter.

Colonel Donald L. Putt—who would go on to attain the rank of lieutenant general, command the Air Research and Development Command in 1953, and serve as the military director of the Air Force Scientific Advisory Board—provided overall guidance for Project Lusty and the collection of aircraft, equipment, and German technical documents in the European theater of operations. Eventually, the German aircraft gathered in Europe, plus V-1 and V-2 missiles, migrated to Freeman Field, Indiana, for evaluation. ATI experts and aviation engineers tested captured Japanese equipment at the Middletown Air Depot south of Dayton. Foreign aircraft also went to Muroc Field (later renamed Edwards AFB), California, for flight-testing, and the U.S. Navy had a test and evaluation center at Patuxent River, Maryland.

Operation PAPERCLIP brought more than 200 German scientists and technicians to Wright Field for collaboration with their American counterparts. Initially assigned to the intelligence branch, most of the scientists eventually went to work in the various Wright Field labs. Colonel Howard M. McCoy organized and headed the Air Documents Research Center (ADRC) in London, England, which translated, cataloged, indexed, and microfilmed captured German documents. In 1946, the center moved to Wright Field and became the Air Documents Division within the intelligence organization. Three hundred people processed more than 1,500 tons of documents, adding 100,000 new technical terms to the English language. The technical knowledge gained from these documents revolutionized American industry. In addition to the aviation-related advances, new designs for vacuum tubes used in communications, the development of magnetic tapes used in tape recordings and computers, night-vision devices, improvements in liquid and solid fuels, and advances in textiles, drugs, and food preservation were made available to American manufacturers. The original ADRC function moved to Washington, D.C., becoming today's Defense Technical Information Center. Other PAPERCLIP scientists, the most famous of whom was Wernher von Braun, helped America develop its space and missile programs.

In the Pacific theater of war, General Douglas MacArthur authorized intelligence personnel to take charge of crashed and captured Japanese aircraft and personnel. Captain Frank T. McCoy and Technical Sergeant Francis Williams helped organize a materiel section for air technical intelligence operations in Melbourne, Australia, in 1942. In addition to providing information on aircraft and weapons performance, Captain McCoy and Sergeant Williams assigned code names to Japanese aircraft—feminine names for bombers and masculine names for fighters. It may not be surprising that "Frank" and "Frances" became the names of two Japanese aircraft. In October 1944, now Lieutenant Colonel McCoy became officer-in-charge of the newly formed Technical Air Intelligence Unit attached to the Far East Air Forces.

The experiences of World War II shaped the future of the U.S. Air Force's scientific and technical intelligence mission. A July 1947 study articulated a threefold mission for ATI:

1. Ensure the prevention of strategic, tactical, or technological surprise from any source.
2. Provide intelligence required for command decisions and counsel upon air preparedness and air operations.
3. Ensure appropriate counterintelligence measures.

Between 1945 and 1950, the mission focus changed. Although the U.S. Air Force's ATI mission had established an office to track Soviet weapons as early as 1943, it remained small; German and Japanese projects were the top priority. ATI efforts turned increasingly toward the emerging technological threat posed by the Russians in the late 1940s.

Bruce A. Ashcroft

See also

Air Technical Intelligence; Japan, Air Operations Against; World War I Aviation; World War II Aviation; Wright-Patterson Air Force Base

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Airborne Battlefield Command and Control Center (ABCCC)

Airborne command and control system for executing air-to-ground and special forces operations. Consists of a mission capsule inside a specially configured EC-130 aircraft.

The mission capsule is a 47-foot, 19,000-pound unit containing 15 consoles. A standard crew consists of 12 positions: Director, Airborne Battlestaff, Battlestaff Operations Officer, four weapons controllers, close air support coordinator, an intelligence officer and technician, two communications systems operators, and a maintenance technician, although the crew can be tailored differently for specialized missions. The crew works at computer workstations that graphically depict areas of interests. The capsule, possessing no onboard sensors, builds a situational representation of the theater through data inputs from other sensor platforms, pilot reports, and coordination with ground combat elements.

The operations officer and controllers provide updated targeting information, process postattack assessments, and coordinate air-to-ground strike requests with other agencies to ensure prompt, efficient targeting. The intelligence section provides and receives threat updates to inbound and outbound strike aircraft, as well as maintaining ground order of battle status. The communications operators provide secure radio and satellite communications capability for the crew. The maintenance technician performs any inflight repair to the ABCCC capsule systems.

The aircraft is an inflight–refuelable EC-130 modified version of the C-130 Hercules transport aircraft. It carries a flight crew of four: pilot, copilot, navigator, and flight engineer.

Braxton Eisel

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Airborne Early Warning (AEW)

AEW involves using sensors carried onboard aircraft to detect, track, report, identify, and respond to adversary air or surface (land or sea) vehicular movement.

First realistically conceived as a U.S. Navy requirement to extend the early detection of enemy aircraft to a carrier fleet in 1942, the first production AEW aircraft, a TBM-3W modified from the Avenger torpedo-bomber, flew in 1945. This early version of a dedicated AEW aircraft, as well as succeeding versions of other modified navel aircraft, all used variants of the APS-20 airborne search radar.

The U.S. Air Force and Navy operated larger AEW platforms starting in the early 1950s. Both used versions of the Lockheed Constellation airliner. This system carried both a search radar in a radome underneath the fuselage and a height-finder radar mounted above the fuselage. Used extensively in orbits designed to detect Soviet bombers attacking the United States, the USAF EC- and RC-121s and the USN WV-2 Warning Star saw service in Southeast Asia, providing radar coverage over North Vietnam.

The U.S. Navy gained its first purpose-built AEW plat-

A sentinel in the sky, the Boeing AWACS is a force multiplier, able to detect enemy aircraft and electronics and control the actions of friendly aircraft. (U.S. Air Force)

form in the E-2 series of aircraft. Carrying a crew of five (two pilots, three mission crew), the E-2 merged the long range of shore-based aircraft with the compactness needed for carrier operations. Numerous countries operate the E-2 both shore-based and afloat.

The U.S. Air Force received its first true AEW aircraft in 1976 with the arrival of the Airborne Warning and Control System (AWACS) based on the Boeing 707 airframe. Carrying a large mission crew and capable of inflight refueling, the E-3 Sentry became the standard for land-based AEW aircraft. It is operated by air forces of the United States, Britain, France, Saudi Arabia, and the North Atlantic Treaty Organization. Japan operates the AWACS system, but on a modified Boeing 767.

Other countries have developed different options for AEW. Some are large, complex systems like Chile's Condor or Russia's Mainstay, but others have opted for smaller, less expensive systems like Sweden's Argus airborne system or the British Royal Navy's helicopter-borne AEW.

The newest entry in the AEW field is that of ground surveillance. Platforms such as the USAF's E-8 Joint STARS system employ a radar optimized for ground reconnaissance. It can detect very small or very slow moving vehicles from long ranges.

Braxton Eisel

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Airborne Laser

The airborne laser (ABL) fires a laser beam that can destroy a short-range ballistic missile (SRBM) hundreds of miles away as it lifts off its launching pad, before it starts its deadly trajectory toward a target. The laser generates heat that forms a stress fracture, and the rocket's internal pressure causes it to burst open. Though a revolutionary weapon, its

The great hope for the future is that an airborne laser can destroy enemy ballistic missiles with a blast of concentrated energy. (Boeing)

technology is off the shelf. Operators on a Boeing 747-400 focus a basketball-sized beam from the laser onto the missile. There are three smaller lasers on the aircraft. One "lights up" a target; a second tracks it; the third is a beacon laser that controls the laser. The ABL uses beam control to find and track a target and adjust the laser as it travels through the atmosphere. The airborne laser's mirror is an adaptive optic. Minute electric actuators, like tiny pistons, distort the mirror to keep pace with atmospheric changes. The ABL is the first truly new weapon of the future battlefield. It will clearly move the U.S. Air Force into a new era. When it enters active duty in the early 2000s, it will be a flying missile defense system. It is mobile and can be in theater in hours, protecting troops on the ground.

David C. Arnold

Aircraft Armament

At the start of World War I, most aircraft were used in purely scouting roles. It was not long, however, before the belligerents experimented with crude offensive devices such as bricks, heavy weights, and metal darts. Rifles and pistols were routinely used as late as 1916, some pilots having success with Martini or Winchester carbines strapped to the struts of a single-seat scout aircraft.

Machine guns were carried on two-seat aircraft from around 1915, typically a .303-inch Lewis or 7.92mm MG-08/15 (Spandau), usually operated by the observer. Initially, guns were mounted on pin and socket mounts on each side of the cockpit, requiring the gun to be manhandled to another socket if an attack developed from an unexpected direction. In 1915, F. W. Scarff of the Admiralty Air Department developed a 360-degree ring mounting that soon became standard equipment on both sides.

The real breakthrough in aerial combat came in April 1915, when Roland Garros mounted a machine gun on his Morane scout and fitted deflector plates to the propeller to deflect the bullets that struck the blades. Garros was eventually shot down and captured, and Anthony Fokker developed the idea into an interrupter mechanism that prevented the gun from firing when obstructed by the propeller. The Fokker E.I Eindecker gave German pilots a significant advantage over the Allies, causing mild panic and hastening the introduction of synchronized forward-firing machine guns on Allied aircraft. The standard fighter armament during the later years of the war and for a number of years afterward was two rifle-caliber machine guns firing through the propeller.

Aircraft Armament (1916–1956)

Year	*Weapon*	*Caliber*	*Rate of Fire*	*Weight*	*Muzzle Velocity*	*Projectile Weight*
1916	Vickers Mk I	0.303 in	850 rpm	24.5 lbs	2,499 ft/sec	0.4 oz
1929	Browning M2	0.30 in	1,150 rpm	21.8 lbs	2,660 ft/sec	0.4 oz
1933	Browning M2	0.50 in	750 rpm	64 lbs	2,750 ft/sec	1.17 oz
1941	Hispano Suiza Mk II	20mm	650 rpm	109 lbs	2,880 ft/sec	4.4 oz
1944	Mauser MG 213 C	20mm	1,400 rpm	165.4 lbs	3,445 ft/sec	4.4 oz (est.)
1956	ADEN	30mm	1,200–1,400 rpm	192 lbs	2,625 ft/sec	8.0 oz
1956	General Electric M61A1	20mm	6,000 rpm	265 lbs	3,380 ft/sec	4.6 oz

As bombers flew higher and faster, low temperatures and the force of the slipstream made it increasingly difficult to aim weapons. An initial solution was to put a protective screen or cupola over the Scarff ring, followed by the introduction of a fully powered turret on the Boulton and Paul "Overstrand" in 1935. All new British bomber designs were modified to include powered turrets where appropriate, usually using twin or quad .303-inch guns. The later U.S. turrets were more effective, with heavier .5-inch weapons and more armor.

In the mid-1930s, it became clear that the increasing use of armor on aircraft would require a heavier-caliber weapon. The Hispano-Suiza 20mm cannon was probably the best weapon available at the start of World War II. In service use it was considered to be reliable and was capable of downing an aircraft with very few hits (about three hits for a fighter-sized target, perhaps 20 for a large bomber).

As World War II approached, fighters were carrying four, six, or eight guns, usually in the wings, and the issue of harmonization (aiming the guns to converge at a point in front of the aircraft) began to assume greater importance. Fighters in the Royal Air Force were initially harmonized at much too long a range in the mistaken belief that a few hits were better than none at all; this was corrected following operational experience during the Battle of Britain.

In 1942, a German requirement for a high-performance cannon led in 1944 to the Mauser MG 213 family of weapons. The 20mm version of this remarkable weapon could fire 1,400 shells per minute with a muzzle velocity of 3445 feet per second, and used a five-chamber revolving cylinder to increase the rate of fire. This gun was the starting point for almost every new gun developed outside the Soviet Union since 1945, including the U.S. M39, the French DEFA, and the British ADEN.

Probably the most important weapon in the West is the GE M61 Vulcan cannon, first used in the Lockheed F-104A in 1954. Its bulk and mass are substantial, requiring an installation tailored individually for each aircraft, yet the performance of the weapon is such that only one is needed. Podded versions of the M61 were used (initially without air-to-air gun sights) on U.S. Air Force F-4 Phantoms in the Vietnam War and were almost immediately successful.

Andy Blackburn

See also
Garros, Roland

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Aircraft Carriers, Development of

Carriers are warships with a flight deck on which airplanes can be launched and landed. Prior to World War I, several of the world's navies commissioned vessels as parent ships for seaplanes. These carriers, all adapted from existing merchant vessels or obsolete warships, featured enhanced handling gear and, often, primitive deck hangars.

When war began, Britain, France, Germany, and Japan all added similar mercantile conversions to their fleets. By 1915, British seaplane carriers incorporated inclined foredeck runways from which seaplanes using wheeled trolleys could take off. Landplanes, offering superior performance, soon supplemented and later supplanted seaplanes, although their crews had to either ditch or attempt to reach land at the end of each mission.

After successful 1917 experiments in landing small aircraft on existing runways, the Royal Navy refitted the converted large cruiser *Furious* with an aft landing deck, retain-

The USS Bunker Hill *was an Essex class carrier and took two kamikaze hits on 11 May 1945. It survived and was ready for action by July of that year but saw no further combat. (U.S. Navy)*

ing the original central superstructure. *Furious* operated successfully throughout 1918, although turbulence made landings hazardous; the arrival of the carrier *Argus* in September demonstrated the superiority of the flush-deck configuration.

At war's end, Britain had commissioned a further cruiser conversion, *Vindictive,* configured like *Furious;* was converting an incomplete former Chilean battleship into a flush-deck carrier with an offset island as *Eagle;* and had laid down *Hermes,* its first vessel constructed as a carrier from the keel up, also flush-decked with an island. Japan laid down *Hosho,* a similar carrier, in 1919, and the United States began conversion of the oiler *Jupiter* into the flush-deck carrier *Langley* in 1920.

Provisions of the 1921 Washington Treaty freed large U.S., British, French, and Japanese hulls for conversion into carriers. The United States and France converted two battle-cruisers and a battleship respectively into the flush-deck carriers *Lexington, Saratoga,* and *Béarn.* British and Japanese concepts emphasizing rapid aircraft launching led both navies to develop designs incorporating multiple flight-deck levels to permit launching of several aircraft simultaneously. Britain rebuilt *Furious* with a three-quarter-length flush deck and a forward launching deck at a lower level and similarly converted two near-sister ships, *Courageous* and *Glorious.* Japan took this idea farther and configured a battleship and a battlecruiser, *Kaga* and *Akagi,* as carriers with two forward launching decks beneath the main deck. Both navies learned through experience that efficient deck-handling procedures were more effective in increasing launch rates, and Japan subsequently rebuilt its two carriers with conventional flush decks.

During the 1930s, Japan and the United States added new carriers to their fleets. Although constrained by Washington Treaty provisions, both navies evolved effective designs that became the basis for later construction. The *Soryu* and *Yorktown* classes combined large flight decks, substantial air groups, strong defensive armament (for the period), high speed, and long range in vessels suitable for extended oceanic operations. Britain, however, was a latecomer to new carrier construction in the 1930s. *Ark Royal,* commissioned in 1939, incorporated internal hangars, an enclosed bow, and a flight deck that was also the vessel's principal strength deck—all features that characterized subsequent British carrier designs.

The carriers that Britain, Japan, and the United States commissioned during World War II derived from their earlier 1930s designs. Japan commissioned the *Shokaku* class in 1941, followed by *Taiho,* a variant incorporating an armored flight deck, and laid down the six-ship *Unryu* class (derived directly from *Soryu*) in 1942–1943, although only two vessels entered service. The United States standardized the *Essex* class, an expansion of *Yorktown.* No less than 32 units were ordered, of which 24 were completed to serve as the backbone of U.S. carrier forces from 1943. They combined powerful offensive and defensive features in hulls whose size conferred great adaptability to changing operational requirements. British wartime carriers introduced armor protection for flight decks and hangar sides. Incorporating this feature into the basic *Ark Royal* design produced vessels that proved very effective in the confined waters of the Mediterranean and in the face of kamikaze attacks, but it also carried severe penalties. Capacity was slashed, hangars were cramped, and it proved difficult and expensive to upgrade these ships after the war.

All three navies commissioned other carriers to meet wartime exigencies. Escort carriers, either simple conversions from mercantile hulls or equivalent new construction vessels, spearheaded antisubmarine operations, provided air cover for convoys and invasion forces, supported amphibious forces ashore, replenished the fast carrier air groups, and trained new aircrews. To circumvent Washington Treaty quantitative limitations, Japan designed fast naval auxiliaries and passenger liners for quick conversion into carriers. From 1940 on, conversions from five auxiliaries and three liners joined the Combined Fleet as frontline light fleet carriers. In addition, Japan converted one *Yamato*-class battleship hull, *Shinano,* into a huge carrier that never entered operational service, and commenced conversion of an incomplete cruiser as a light fleet carrier. The United States also deployed converted warships—the nine *Independence*-class light fleet carriers based on *Cleveland*-class cruiser hulls formed an integral part of the fast carrier force from early 1943.

Britain also appreciated the need for smaller, less-sophisticated carriers that could enter service more quickly but chose to construct new vessels rather than convert existing hulls. Four *Colossus*-class light fleet carriers served with British Pacific Fleet in late 1945 and joined six sisters to form the core of British carrier power into the later 1950s, operating throughout the Korean War and at Suez in 1956. Many of them, as well as the five semisisters of the *Magnificent* class, later went to other navies, serving with Argentina, Australia, Brazil, Canada, France, India, and the Netherlands. Four larger updated carriers of similar design entered the Royal Navy after World War II, serving as fleet carriers and later as amphibious assault ships. The last, *Hermes,* saw action in the Falklands in 1982 and was sold to India in 1986.

Jet aircraft operation affected carrier design. Long takeoff and landing runs, heavier aircraft, higher approach speeds, and slow throttle response marginalized safe operation from existing carriers. Three British inventions—steam catapults, angled flight decks, and optical landing aids—made routine jet operation practical but forced changes in ship design. Navies reconstructed their existing larger, more modern carriers and modified the designs of vessels still under construction. The U.S. Navy, whose axial-decked *Midway*-class carriers had already set a new benchmark for size, led the way in adopting these innovations in new construction. The four *Forrestal*-class supercarriers and their improved *Kittyhawk*-class half-sisters became the prototypes for all subsequent U.S. fleet carriers, whose current design crystallized when nuclear power was adopted for *Enterprise,* commissioned in 1961. These carriers are marked by their huge size (angled flights decks run more than 1,000 feet and are 250 feet wide), four long, powerful steam catapults, and sophisticated landing aids—all essential to operate air groups of some 80 jet aircraft. Other navies have not been able to afford carriers of this size, but their smaller conventional vessels have been much less capable.

Since the 1970s, V/STOL aircraft have added a new dimension to carrier design. Britain, the Soviet Union, and Spain commissioned smaller carriers specifically configured to operate a mix of V/STOL jet attack or fighter aircraft and large antisubmarine helicopters, epitomized by the British *Invincible* and Soviet *Kiev* classes. These types, however, trade smaller size and less demanding equipment (they do not need catapults and arresting gear) for a less capable air group, particularly in range and the ability to incorporate long-range early warning and antisubmarine search aircraft.

Paul E. Fontenoy

See also

Airborne Early Warning; anti-submarine warfare; Atlantic, Battle of the; Bismarck, Air Operations Against; British Pacific Fleet; Canadian Air Force; Cape Engano, Battle of; Coral Sea, Battle of the; DESERT SHIELD; DESERT STORM; Eastern Solomons, Battle of;

Falkland Islands War; Fleet Air Arm; French Naval Air Force; Iwo Jima; Japanese Naval Air Force, Imperial; Kamikaze Attacks; Korean War; Leyte Gulf, Battle of; London Naval Agreement; Marshall Islands; Mediterranean Theater of Operations; Midway, Battle of; Norwegian Air Campaign; Okinawa; Santa Cruz, Battle of; Suez Crisis; Taranto Air Attack; Task Force 38/58; Task Force 77; United States Navy, and Aviation; USS Langley; Washington Naval Conference

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AirLand Battle

The official U.S. Army warfighting doctrine during the Gulf War. First announced in 1982, it was formulated at the Army's Training and Doctrine Command at Fort Monroe, Virginia, and at the Army Command and General Staff College at Fort Leavenworth, Kansas, in coordination with the Air Force's Tactical Air Command. Revised in 1986, AirLand Battle doctrine reintroduced the concept of operational art, the intermediate level of war between military strategy and tactics, that was to define the modern battlefield.

Under this doctrinal concept, combat included not only fighting along the line of contact—now called close operations—but also deep operations "directed against enemy forces not in contact [to] create the conditions for future victory," as well as rear operations to assure freedom of maneuver and protection of critical logistical resources. It envisioned Army–Air Force cooperation and mutual support and called for simultaneous battles on the forward line and deep in the enemy's rear echelon in close concert with airpower.

AirLand Battle marked a definite turning away from atomic theorists, who maintained that conventional war was obsolete in the nuclear age. Emphasizing campaign planning, maneuver, and fluidity of action, AirLand Battle was validated in the Gulf War.

James H. Willbanks

See also

Close Air Support; Tactical Air Command

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Airlift Operations, U.S.

The first U.S. airlift operations began during World War I using four British-designed de Havilland DH-4 biplanes to drop supplies to the beleaguered Lost Battalion in the Argonne Forest. One aircraft was successful, and the crew, consisting of Lieutenants Harold Goettler and Erwin Bleckley, were posthumously awarded of Medals of Honor for their actions on 6 October 1918.

Airlift operations within the U.S. military began in the mid-1920s. The aircraft primarily supported operations of combat and headquarters units. The first transport aircraft for the U.S. Army Air Service, built in 1919, was the Martin T-1, based on the MB-1 bomber. Its fuselage was redesigned to enclose the cockpit and provide accommodations for up to 10 passengers.

For the brief period 15 May-29 August 1919, the Army flew mail for the U.S. Postal Service. First in this long series of aircraft was the Douglas C-1, an enlarged version of the famed World Cruisers that made the first round-the-world flight in 1924. Transport aircraft were procured in small quantities of one to 10 from the C-1 through the C-31, indicating the low priority of such aircraft to the service (the General Aircraft [American Fokker] C-14 was the exception, with 20 being procured). It was not until the advent of the Douglas C-32 (the military version of the commercial DC-2) that airlift became a serious issue with the military.

In fiscal year 1942, the Army procured 24 C-32s as troop transports, 18 C-33s for freighters, and a pair of C-34s as VIP transports. That year was also the start of orders for 3,144 Curtiss C-46 Commandos, capable of carrying 50 troops. A total of 9,583 Douglas C-47 Skytrains (the military version of the commercial DC-3) were also produced for the Army as well as the Navy and Allied nations. Both the C-46 and C-47 saw service during World War II and Korea. The C-47 soldiered on through the Vietnam War.

Management of such a large transport force was a major undertaking. First, the operations were divided between strategic and tactical airlift. Strategic operations initially began with ferrying Lend-Lease aircraft to England. This mission was performed by the Air Corps Ferrying Command, established on 29 May 1941. By 7 December 1941, the command had delivered some 1,300 aircraft to the Allied forces around the world. Ferrying Command was redesignated Air

Transport Command (ATC) on 20 June 1942, and although it continued its role in ferrying aircraft, it was primarily tasked with providing all strategic airlift for the War Department, delivering personnel and materiel critical to the war effort throughout the world. At its peak, ATC had more than 3,700 aircraft supported by more than 300,000 personnel.

The first ATC was activated on 1 May 1942. The command was designated the I Troop Carrier Command in July 1942. This organization was a major command that reported directly to Headquarters Army Air Forces and was responsible for training troop carrier units and personnel within the United States for parachute troops, airborne infantry, and glider units. The I Troop Carrier Command was disbanded on 5 November 1945. Theater operations were conducted by the IX Troop Carrier Command, activated in England on 16 October 1943.

With the end of World War II, a major postwar demobilization occurred on 31 March 1946. Headquartered at Greenville Army Air Base, South Carolina, the Third Air Force (Troop Carrier) served as the sole troop carrier organization within the Army Air Forces between 21 March and 1 November 1946, until absorbed into the Ninth Air Force and losing all mission identity. It was not until 20 March 1951 that the Eighteenth Air Force was established within Tactical Air Command (TAC) with the specific mission of troop carrier operations in support of the Army.

Units of the Eighteenth Air Force were transferred to the Far East Air Forces Combat Cargo Command during the Korean War. Initially, the Combat Cargo Command was a provisional unit. On 5 January 1951, the unit was designated the 315th Air Division (Combat Cargo). Throughout the war, elements of this unit provided all major airlift utilizing C-46, C--47, Fairchild C-119, and Douglas C-124 "Globemaster IIs." The Eighteenth Air Force continued troop carrier operations within the United States until 1 January 1958, when the mission was transferred to the Twelfth Air Force.

The Air Force Reserve provided troop carrier units to augment the active-duty forces. Nineteen Reserve groups were activated for the Korean War. In 1957, the Reserves dropped their fighter role and almost exclusively performed troop carrier operations with 45 squadrons. An excellent showing of the Reserve troop carrier units during an exercise in August 1960 proved their capabilities, resulting in TAC and the Army regularly asking for their services. For 19 years, the Reserve troop carrier units employed the C-119 as their principal aircraft.

The Naval Air Transport Service (NATS) was formed on 12 December 1941. Though much smaller than the Army's ATC, NATS was equipped with 429 aircraft supported by 26,000 personnel. Its mission was to provide a global air transportation network between naval establishments and naval areas of operation.

The postwar reorganization of the military inevitably led to a new air transportation command that would serve most airlift needs of all services and the Department of Defense. On 1 June 1948, both ATC and NATS were discontinued, inactivated, and replaced by a new joint command: the Military Air Transport Service (MATS). The new organization was commanded by USAF Major General Laurence S. Kuter, with USN Rear Admiral John P. Whitney as vice commander. MATS reported directly to the USAF Chief of Staff. Upon its establishment, MATS had 766 USAF and 58 USN aircraft and was manned by 54,164 personnel from the Air Force, Navy, and Civil Service. MATS operated three divisions: Atlantic, Continental, and Pacific—each providing service within its own geographic areas.

In addition to airlift, MATS also controlled the Airways and Air Communications Service; Air Photographic and Charting Service; Air Weather Service; Air Rescue Service; and Flight Service (the latter providing operational control of all military aircraft operating within the United States).

Operation VITTLES—the Berlin Airlift—became the first test of MATS when the Soviets blockaded the city of Berlin on 25 June 1948. The airlift succeeded admirably. In it airpower in the form of compassionate relief became a major diplomatic weapon.

On 7 December 1956, the Department of Defense designated MATS as the single manager of all airlift service; however, other commands had smaller integral airlift capabilities. The command began with gaining a pair of C-124–equipped heavy troop carrier wings from TAC.

MATS was designated Military Airlift Command (MAC) on 1 January 1966. In addition to its strategic airlift mission, it gained the traditional base flight operations for all other commands within the USAF. MAC designated the former MATS Eastern Transport Division the Twenty-first Air Force; the Western Transport Division the Twenty-second Air Force; and the Air Rescue Service became the Aerospace Rescue and Recovery Service under the Twenty-third Air Force. MAC also designated the Air Photographic and Charting Service the Aerospace Audio-Visual Service. The Air Weather Service essentially remained the same. Because of its joint service mission, MAC was designated a specified command on 1 February 1977, thereby coming under the direction of the Joint Chiefs of Staff. MAC was designated Air Mobility Command (MAC) on 1 June 1992, essentially retaining all of its missions.

As the military did not have sufficient airlift capability for a major international emergency, the Civil Reserve Air Fleet (CRAF) was instituted in 1952. Commercial airlines identified certain aircraft and crews that could be called up (much like the Air National Guard and Reserve forces) to supplement the USAF's airlift requirements. Participating airlines dedicated 300 C-54–equivalent four-engine aircraft to CRAF. Although civilian airlines routinely supported USAF requirements, it was not until the Gulf War in 1990 that CRAF was activated.

In July 1960, after hostilities erupted in the Congo when Belgium gave that nation its independence, MATS dedicated a large portion of its airlift capability for support until January 1964, when peace was established. During this period, MATS flew 2,128 missions, transporting 63,798 personnel and 18,593 tons of cargo. This was known as Operation NEW TAPE. Lessons learned showed that MATS would be required to take on a combat role in the form of airdrop and paratroop operations. By the mid-1960s, these combat missions were transferred from TAC to MATS.

MAC evolved from an all–piston-powered organization to one equipped with all-turbine aircraft during the 1960s. In addition, air refueling was added to their mission—transport crews were trained to receive fuel from Strategic Air Command (SAC) tankers.

Between 1964 and 1973, MAC provided the bulk of the strategic airlift for the Vietnam War. MAC also flew tactical airlift operations within the theater. MAC personnel flew air-rescue missions, provided air weather service, and audiovisual services in the theater. When North Vietnamese units encircled U.S. Marines at Khe Sanh, South Vietnam, in mid-December 1967, it was tactical airlift that kept the ground forces supplied.

On 12 May 1968, a U.S. Special Forces camp at Kham Duc was overrun by communist forces. In the course of the day, it was learned that a three-man tactical control team had been left behind at the base. Lieutenant Colonel Joe M. Jackson landed his Fairchild C-123 on the field and successfully evacuated the team. For his actions that day Colonel Jackson became the only airlifter to be awarded the Medal of Honor.

In October 1973, the MAC airlift supplying arms and supplies to Israel was considered by many to be the decisive event in the eventual victory of Israeli forces over those of Egypt and Syria. The airlift also validated the Lockheed C-5A as an indispensable airlift aircraft.

During the Gulf War, MAC aircraft were the air bridge required to provide most all of the initial requirements for the Coalition forces. The sealift required three weeks to sail to the Gulf region. Afterward, MAC provided a continual aerial supply line for critical cargo and the bulk of the U.S. personnel movement between l990 and 1991.

With the change from MAC to Air Mobility Command (AMC) on 1 June 1992 came the transfer of SAC's KC-135 and KC-10 tanker fleet.

The United States Transportation Command (USTRANSCOM), a joint-services organization reporting to the Joint Chiefs of Staff, was organized on 1 April 1987 and activated on 1 October 1988. USTRANSCOM headquarters is colocated at Scott AFB, Illinois, with the AMC, and commanded by the commander in chief of AMC. The new command oversees all air, sea, and land transportation requirements for the Pentagon.

The mission flexibility of America's airlift forces permit it to not only perform its military function but also serve humanity. Between 1947 and 1994, USAF transport and rescue aircraft flew 568 humanitarian missions around the world, not counting the thousands of times combat aircraft had flown vitally needed vaccines and human organs. The United States is the only nation that has the capability to deliver such aid anywhere in the world on a moment's notice.

Alwyn T. Lloyd

See also

Berlin Airlift; Boeing KC-10 Extender; Boeing KC-135 Stratotanker; Fairchild C-82 Packet and Fairchild C-119 Flying Boxcar; Strategic Air Command; Tactical Air Command

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Airlines, Service in Wartime by

As the United States entered World War II in late 1941, the military was woefully short of air transport capacity. Although hundreds of transports (chiefly C-46s and C-47s) were on order, few had been delivered. Given the pressing need to build up strength, the only place to obtain needed air transport was from the nation's airlines. Air carriers had focused on passenger and mail traffic rather than cargo (commercial freight amounted to but 2–3 percent of airline gross revenues before Pearl Harbor), yet they could provide trained pilots as well as aircraft to fly. The airlines quickly grew to reflect wartime needs as carriers radically changed how they operated, though at no time were the airlines wholly taken over by the military. The changes began with airliners themselves.

In a series of War Department decisions in December 1941 and early 1942, the Air Corps Ferry Command (Air Transport Command [ATC] in June 1942) requisitioned 193 out of the total U.S. airline fleet of 359 airplanes. Most were twin-engine DC-3s with a handful of four-engine Boeing 307s and 314s. Often the trained crews went with the aircraft, placing the civilian fliers under military orders. New four-engine DC-4s and Constellations under order for the airlines when the war began were diverted to military needs and became C-54s (heavily used in all theaters) and C-69s (only a few by 1945).

Airline aircraft and crews accomplished 88 percent of ATC transport work in 1942, but as the military built up its own air transport capacity, the role of airlines declined—to 68 percent in 1943, only a third by 1944, and about 20 percent in 1945. ATC operated 1,000 of its own aircraft by end of 1943 and 3,700 by end of the war less than two years later. Thus, by early 1944 many of the requisitioned airliners began to be returned to their original owners, easing some of the limitations on civilian flying.

Under the press of government and military need, airliner usage and load factors sharply increased. With more than half its fleet out of the picture, an airline system of priority use was put into place immediately; government-priority mandates came into force in early 1942. Under these, military and other government needs came first; civilians flew only if space was available (rare during the first two years of war). Slowly, a massive program of airfield building and improvements made it easier. During the war, airports went from small grass fields in many cases to massive cement runways, allowing larger aircraft, longer takeoffs, and heavier take-off and landing weights. Although most of these were military at first, many became civil airfields after the war.

Most airlines greatly expanded their routes as military needs dictated. This new service would lay the groundwork for arguments over postwar airline operations. This was especially true of transoceanic services, where Pan American's prewar monopoly was broken under the pressing need for more capacity. TWA, for example, became a transatlantic service, ferrying high-priority personnel and cargo to and from Britain. Northwest and United expanded operations to Alaska and Hawaii, respectively. American Export Airlines, though created by the shipping company American Export in 1937, began flying its three VS-42 four-engine flying boats across the Atlantic in mid-1942. Pan Am expanded on its own overseas service. In a series of agreements with the U.S. and British governments in mid-1941, Pan Am created three subsidiaries to undertake special missions. Pan American Air Ferries was established to deliver American aircraft to Khartoum from Miami. Pan American Airways Co. was created to operate an air service from the United States to West Africa. And Pan American Airways-Africa, Ltd., focused on developing the airfields, and then air service, across Africa. This service was extended to Cairo and Tehran after the United States entered the war.

Airlines provided key personnel to the military. At the top, for example, American Airlines President Cyrus R. Smith became the deputy to assist Gen. Harold George in building up the ATC. Smith's operational experience was vital in the rapid development of the military's own cargo and passenger capacity. But thousands of others—especially pilots and mechanics—followed, either working on military projects under contract or going directly into the military. This infusion of talent was vital to the relatively short time it took to create a high-capacity military air transport operation.

Among the Allied powers, airline operations all but stopped save for direct military support roles. Britain's Imperial Airways (which became BOAC in mid-1940) ceased civil operation and came under military command. Headquarters were relocated west to Bristol; landplane and seaplane bases moved farther west as well. Imperial maintained civilian service between London and Paris until the German occupation of the latter in June 1940. Flying-boat services to Africa and the Horseshoe Route around the Indian Ocean to Australia and New Zealand began in mid-1940 and operated until Japanese advances in early 1942. Then Australia's QANTAS flew Catalina seaplanes from Ceylon to Perth, a distance of 3,500 miles; these "double sunrise" flights made up the longest nonstop air route of the war and took 27–30 hours with a 1,200-pound payload. To the extent their equipment escaped loss through battle or occupation, KLM, Sabena, Air France, and QANTAS (among others) used their surviving airliners or were forced to use "interim types" (converted bombers) as further development of promising airliners had to be cancelled for the duration. In the Far East, China's CNAC conducted refugee flights as well as food and cargo deliveries. Facing extreme problems of airliner and airport maintenance, especially in the celebrated flights over the Himalayan Hump, CNAC made a big contribution in the war against Japan.

Airlines of the Axis nations saw their fortunes more directly impacted by the battlefield. Germany's Lufthansa, about to launch service to South America, across the North Atlantic, and even to Asia when the war began in 1939, saw these plans quashed (not to be realized for two decades) and operated routes only in occupied Europe and to Spain. Its final service in May 1945 was from the northern German coast into Norway (Lufthansa was banned from resuming service until 1955). Italy's Ala Littoria served Germany and Italian colonies in North Africa. Japanese airlines came under direct military control, with extensive army and navy routes to Southeast Asia and out to Pacific islands (Japanese airline service was banned from 1945 to 1952).

The Korean War (1950–1953) again forced the military to turn to airlines for help, though on a far smaller scale. Trans-Ocean, United, Pan American, and Northwest, all with Pacific experience, flew for the Military Air Transport Service, carrying troops and priority cargo into staging airfields in

Japan (the military flew into Korea itself). Drawing on the Korean experience, in 1952 the Air Transport Association (the airlines' trade organization) and the Department of Defense cooperated to create the Civil Reserve Air Fleet (CRAF). This established the specific airliners the military could automatically requisition. CRAF included government financing to enhance the cargo-carrying capacity of airliners, especially of wide-body jets after 1970.

The several Middle East wars from the 1950s into the 1970s proved the value of a national airline when El Al was the only carrier to connect Israel with the outside world. El Al stripped interiors to carry freight and to evacuate tourists and then had to deal with the sharp drop-off in tourism traffic after each conflict. In the 1990–1991 Gulf War, 11 scheduled and 13 supplemental carriers took part under CRAF in 5,300 missions carrying 64 percent of troops and 27 percent of war cargo.

CRAF did not play a part in the Vietnam War because the U.S. military buildup, beginning in 1961, was so gradual. World and other supplemental carriers as well as major airlines provided regular charter service, carrying military personnel into the battle area and out for recreation in East Asian and Hawaii. Some "airline" operations, such as Air America, were really camouflage for covert operations by the CIA. And several carriers were on hand for the final evacuations as the war ended. CRAF was used with good results in the Gulf War.

Christopher H. Sterling

See also

Air America; Berlin Airlift

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Airships

Prior to World War I, Germany had pioneered the development of the rigid airship. This was principally the work of one man, Count Ferdinand von Zeppelin, who had become intrigued with the thought of lighter-than-air flight after observing the use of balloons during the American Civil War. In November 1909, Zeppelin airships equipped DELAG, the world's first commercial airline operation. Development work continued in the years prior to the war, funded largely by public subscription and government investment. The giant airships became a source of national pride, and despite the fact that other manufacturers entered the field, the name "Zeppelin" was so closely associated with their construction that it has become synonymous with the word "airship."

The rigidity in a rigid airship came from a welded duralumin framework that formed the body of the cigar-shaped craft. Inside this skeleton were a number of gas cells containing the highly flammable hydrogen that made the ship lighter than air. The inside of the body was accessible during flight for maintenance and repair purposes, entry being gained by ladder from the gondolas suspended beneath its underside, lateral movement running over a catwalk that spanned the length of the ship. Engines housed in the gondolas provided forward movement. Later models had a machine gun station on the top of the envelope for defense against aerial attack.

The German army and navy both operated airships, but it was the Naval Airship Division, under the zealous direction of Fregattenkapitän (Frigate Captain) Peter Strasser, that really made the giant craft famous.

The German Zeppelins became a matter of national concern for the British. In the early days of World War I, the British imagined they might be attacked at any moment, but the Zeppelins did not attack until the night of 19–20 January 1915.

Early in the war, British response to the attacks was weak. Searchlights would seek out the Zeppelins, and ground fire would be aimed in their direction, but defending aircraft were too slow in climb rate and lacked adequate performance to reach the altitudes where Zeppelins operated. It was 2 September 1916 before an airship (the Schütte-Lanz SL11) was downed on British soil. The victor was Second Lieutenant William Leefe Robinson, who received the Victoria Cross for his feat.

Improvements came on both sides, but fighter performance eventually matched and then overtook progress in airship design, leading to a decrease in the frequency of Zeppelin attacks and, in time, their suspension in favor of a bombing program built around Gothas and *Riesenflugzeug* (giant aircraft).

The biggest airship disaster of the war came on the night of 19–20 October 1917 in the so-called Silent Raid, so named because the airships reached such great heights over England (three of the Zeppelins making it past 21,000 feet, the L55 reaching 24,000 feet) that their engines could not be heard; the Silent Raid resulted in the loss of five of the 11 ships that left Germany for London. It was a victory for

Mother Nature, however, not the British defense, as the airships fell victim to gale-force winds that had not been predicted prior to their departure. The raid marked the beginning of the end for the airship as a military weapon.

Over the course of the war, the Naval Airship Division mounted 306 raids, which succeeded in getting 177 ships over England and producing £1,527,544 in property damage in Great Britain, against the loss of 53 airships. The last to be lost, the L70, went down before the guns of Major Egbert Cadbury and Captain Robert Leckie during the last airship raid of the war, on the evening of 5–6 August 1918. On board, in personal command of the raid, was the Leader of Airships himself, Peter Strasser.

Although less glamorous and accorded far less attention than the raids on England, reconnaissance airships arguably performed more valuable work for naval operations in the North Sea and the Baltic. Over the North Sea, they had made 971 scouting flights, more than three times the number of flights devoted to raiding England. These flights took place over the 399 days that weather made it possible (out of the 1,559 total days of the war) for an impressive 25.6 percent ratio.

The bulk of British achievement came in nonrigid form. Nonrigid airships, generically known as blimps, lacked the complex internal structure of their rigid counterparts and, like balloons, relied on the pressure of the lifting to maintain the ship's shape. British nonrigids also had less complex provision for the crew. Many times, in fact, the British gondola simply consisted of an airplane fuselage stripped of its wings and tail assembly and hung from the underside of the gas envelope. The nonrigid was also much smaller than the typical Zeppelin, with the crew generally numbering no more than two or three. Used for scouting purposes, some of the British airships carried a small bombload for use against enemy ships that might be encountered. Their chief value was in their ability to spot the enemy and then place a wireless call to nearby surface craft, which were better suited to handle the problem.

At the beginning of the war, airships were generally limited to patrols of 2–4 hours. By the war's end, duration had increased to an impressive 12 hours (an improvement that certainly was hard on the crew), but airspeed was still as little as 5–10 mph if adverse winds were encountered.

Like their heavier-than-air counterparts, airships, whether rigid or nonrigid, contributed more to World War I by what they could see than what they could hit. By the time hostilities renewed in 1939, aviation technology had progressed to the point that airships' low performance was no longer acceptable, and they had long since passed from the military scene.

James Streckfuss

See also

Balloons; German Naval Airship Division; World War I Aviation

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Alam el Halfa, Battle of (1942)

Marked the defeat of the Afrika Korps's last attempt to reach Alexandria. Within 17 days of assuming his Egyptian command, General Bernard L. Montgomery led his first major action against the Afrika Korps's final effort to break through the Eighth Army's defenses and gain the Suez Canal. The successful British repulse of Axis forces at Alam el Halfa (31 August–6 September 1942) enjoyed massive assistance from the RAF and USAAF flying combined in the Western Desert Air Force.

German Field Marshal Erwin Rommel noted after the battle that Allied airpower rendered all of his tactical plans useless. He bitterly likened his troops to nineteenth-century "savages" in the face of sustained, heavy aerial attacks.

These attacks actually began on 21 August and wrecked Rommel's motorized and armored formations, broke up his infantry concentrations, and struck his supply dumps. Allied pilots also played havoc with Axis lines of communication and reinforcement. In addition to units of the RAF and South African Air Force, the USAAF's 57th Fighter Group (equipped with Curtiss P-40s) and the 12th Medium Bomb Group (operating North American B-25s) participated in the action.

After Alam el Halfa, the Eighth Army never again lost air superiority to Rommel's forces.

D. R. Dorondo

See also

El Alamein, Air Battles of; North African Campaign; Regia Aeronautica (World War II)

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Albatros Aircraft

Next to Fokker, Albatros designs are probably the best-known German aerial products of World War I. Unlike

Fokker, however, the activities of the Albatros factory were not confined primarily to the design and production of fighters. Throughout the war, it turned out aircraft aimed at fulfilling practically every air service function, including unarmed trainers (B types), armed two-seaters (C types), seaplanes (W types), armored ground attack aircraft (J types), bombers (G types), and, of course, the famous Albatros D line of single-seat fighters. The *Riesenflugzeug,* or giant aircraft, was the notable exception.

Thousands of Albatros aircraft were built, and they served on every front on which the German army and navy fought. It is perhaps ironic that only two original Albatrosses survive today, both of them D.Va single-seat fighters: one in the National Air and Space Museum in Washington, D.C., the other in the Australian War Memorial in Canberra.

Despite their varying functions, Albatros designs had a strong family resemblance. All had a plywood-covered, semimonocoque fuselage, which provided strength beyond the normal wood-framed, wire-braced structure of the day. Use of Mercedes, Benz, or Argus inline engines of various horsepower ratings was also common to Albatros designs.

Armament on the two-seaters consisted of a Parabellum machine gun for the observer, fitted to a rotating ringmount and, after the invention of the interrupter gear, a single Spandau gun mounted on the engine hood that fired through the propeller. On the single-seat D fighters, twin Spandau guns were carried.

The best known of the Albatros stable was the D.III, the single-seater that devastated the Royal Flying Corps (RFC) during the spring of 1917. The fuselage of the D.III and its successors, the D.V and D.Va, was vintage Albatros, but the sesquiplane wing layout was inspired by the success of the Nieuport. The bracing that connected the upper wing to the lower gave rise to the nickname "V-strutter" in RFC combat reports. It also led to occasional wing failures when thrown about in combat, a problem that contributed to its eventual replacement by the Fokker D.VII. A D.III variant used by Austria-Hungary was preferred over its own designs and had better performance than its Western Front counterpart.

Like other German aircraft manufacturers, Albatros became a victim of the aviation ban imposed on Germany by the Versailles Treaty and disappeared following World War I.

James Streckfuss

See also

Fokker Aircraft (Early Years)

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Alenia

The leading Italian aerospace company. Alenia was formed on 20 December 1990 following the decision by the IRI-Finmeccanica state conglomerate to merge its subsidiaries Aeritalia and Selenia into a single high-technology company with improved international competitiveness. The liquidation of state conglomerate EFIM also brought Agusta into IRI-Finmeccanica, whose restructuring thus came to coincide with the painful rationalization of the Italian aerospace industry. Alenia completed the key Aeritalia programs, including Tornado and AMX, but sold or discontinued marginal businesses like Partenavia. To facilitate international alliances, in 1997 Alfa Avio was sold to Fiat Avio; Alenia then split into Alenia Aerospazio and Alenia Difesa, the latter comprising the radar, missile, and OTO Melara activities. In 1998, Alenia Difesa joined Marconi to form Alenia Marconi Systems.

In April 2000, the Alenia military product line comprised the Eurofighter Typhoon, C-27J airlifter (with Lockheed Martin), ATR42 maritime patrol versions, and the Airbus A400M airlifter project; commercial aircraft included the ATR commuter (more than 600 built) and major structural components for several Airbus, Boeing, and Dassault types, plus overhauls and conversions. Space activities included satellites as well as various inhabited and structural elements of the International Space Station.

Gregory Alegi

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Aleutian Islands Air War

U.S.-Japanese conflicts in U.S. territory during World War II. The prospect of an enemy conquest of Alaska was very real when a Japanese task force moved against the Aleutian Islands in 1942. Japan sought to establish bases from which to strike the U.S. West Coast. Although strategically positioned, the extreme climate of the region rendered it a difficult area for aviation. Nearly continuous fog, high winds, extreme cold, williwaws (blizzards), and mountainous islands make the Aleutians a risky place to fly even today with the most modern equipment. In the 1940s, it was extremely hazardous.

The Japanese established bases at Attu, on the west end of the Aleutians, and nearer to Alaska, at Kiska. Allied forces fought off an attack on Dutch Harbor (3–4 June 1942). U.S. bases at Cold Bay and Umnak were supplemented farther out the island chain on Adak and Amchitka. Airplanes were often overturned in their parking spots by the ferocious williwaws. Supply problems added to the burden.

The Japanese also suffered from the weather, and the U.S. Navy's blockade made resupply nearly impossible. U.S. bombers repeatedly struck the Japanese garrisons.

Finally, in May 1943 the United States seized Attu. U.S. fighters and bombers supported the three-week operation. In the only air-to-air battle of the campaign, five Lockheed P-38s drove off 16 Mitsubishi G4M "Betty" bombers, dispatched from the Kurile Islands north of Hokkaido. Only seven Japanese aircraft returned home. No further support was forthcoming for the Japanese on Attu. The Americans were victorious, but nearly 4,000 G.I.s were casualties, many due to cold and frostbite. Only 28 of the 3,000 defenders were taken alive. Kiska was evacuated by the Japanese navy, in great secrecy, under the cover of the dreadful weather, much to the relief of invading U.S. and Canadian soldiers.

Attu and nearby Shemya Island served as bases for a campaign against the Kuriles. During the last two years of the war, 1,500 sorties were flown against the northern reaches of Japan, hitting naval and air bases. These operations by a few dozen bombers tied up 500 enemy airplanes (more than 10 percent of the Japanese air force at war's end) and more than 40,000 troops by threatening invasion from the north, the same worry that had haunted U.S. planners in 1942. The Aleutian campaigns cost the United States 56 airplanes in combat and 209 to weather. Japanese losses also reflected the harsh climate: 69 combat losses against 200 weather losses.

Aleutian bases established during World War II went on to play a prominent role throughout the long Cold War struggle.

James M. Pfaff

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Algeria

From 1954 to 1962, France sought to maintain control of its colony in Algeria using a mix of ground, naval, and air forces to fight Algerian rebels. Initially, air operations remained limited due to the commitment of aircraft and personnel to the Indochina front.

By 1959, however, some 40 percent of French airpower was on Algerian territory, and another 20 percent based in France supported the effort. The hardware eventually amounted to some 600 airplanes and 600 helicopters from the three services. The air interdiction practices allowed the French to seal off the Algerian border, preventing rebel support from neighboring Morocco and Tunisia. In addition, heavy helicopter use to ferry commandos helped defeat organized rebel forces. However, such efforts failed to remove the psychological impact of war and ongoing terrorism, to the point where negotiations between the two sides led to Algerian independence in 1962.

Guillaume de Syon

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Alksnis, Yakov I. (1897–1940)

Commander of the Red Air Force during the 1930s. Yakov Ivanovich Alksnis was born in 1897 in Latvia. He joined the Bolshevik Party in 1916 and participated in the Russian Revolution and civil war. Remaining in the Red Army, he became an aviator during the 1920s, and in June 1931 he was appointed commander of the Red Air Force. He was closely associated with Mikhail Tukhachevsky, a former Chief of Staff and later marshal of the Soviet Union, and under his command the Red Air Force saw rapid expansion and modernization. Notable was the large-scale introduction of the TB-3, the world's first four-motor monoplane bomber, though these bombers were not intended as an independent strike force. He also oversaw the dispatch of pilots to fight in Spain. In December 1937, during the purge of the Soviet high command, Alksnis was arrested on false charges of treason. He was executed in 1940.

George M. Mellinger

See also

Polikarpov, Nikolai N.; Soviet Volunteer Pilots; Tupolev Aircraft

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ALLIED FORCE (1999)

NATO code name for peacemaking air campaign designed to protect ethnic Albanians in the Yugoslav province of Kosovo from Serb aggression and to force Yugoslav authorities to agree to a peace settlement. Operation ALLIED FORCE is often hailed as the first time in military history that airpower has achieved victory in a conflict on its own. Indeed, Operation ALLIED FORCE played a prominent role in ending ethnic cleansing in Kosovo, returning more than 840,000 refugees to their homes and restoring a semblance of peace to the troubled province.

Operation ALLIED FORCE rose from the ashes of the failed Rambouillet peace negotiations in January-February 1999, when a Serb delegation refused to accept a NATO peace plan for Kosovo. As negotiations collapsed on 19 March, Yugoslav President Slobodan Milosevic initiated Operation HORSESHOE, an operation designed to cleanse Kosovo of its ethnic Albanian population by force before NATO forces could be brought to bear. In the face of Yugoslav intransigence and escalating violence in Kosovo, NATO decided to proceed with Operation ALLIED FORCE on 24 March.

Initially, ALLIED FORCE was intended to be a short conflict with limited objectives. NATO would demonstrate its resolve to Milosevic, who would accept a negotiated settlement in the face of a limited NATO bombardment. ALLIED FORCE would then achieve its objectives of stopping the killing in Kosovo, returning refugees to their homes and creating the conditions for a political settlement. For the first nine days of the operation, NATO aircraft focused on so-called Phase I targets: the Yugoslav Integrated Air Defense System, command and control, and heavy weapons in Kosovo. NATO had 214 combat aircraft at its disposal as the conflict began, arrayed against a Yugoslav air defense system equipped with 16 MiG-29 Fulcrum fighters. Regardless, NATO aircraft achieved air superiority on the first night of the war. To avoid aircraft losses, Lieutenant General Michael Short restricted NATO fliers to a minimum altitude of 15,000 feet.

When Milosevic did not give in, NATO moved on to Phase II targets on 3 April and began targeting Yugoslav military forces south of the 44th Parallel. As the conflict continued to drag on and the refugee crisis worsened, ALLIED FORCE began to focus on the morale of the Serb public rather than Milosevic himself. On 1 May, NATO expanded its target set to include lines of communications, refineries, and electric power grids in Serbia. Despite a major setback following the accidental bombing of the Chinese Embassy on 7 May, NATO aircraft kept up a steady effort of about 250 combat sorties per day until Yugoslav military authorities agreed to NATO demands on 9 June.

Although historian John Keegan lauded ALLIED FORCE as proving a war can be won by airpower alone, Milosevic's capitulation coincided with other key events of the conflict. In the last days of May, NATO leaders began publicly discussing options for a NATO ground offensive against Yugoslavia before the end of 1999. In addition, rebels of the Kosovo Liberation Army began a major offensive against Yugoslav forces in Kosovo on 26 May. Although the offensive failed, Yugoslav forces were forced to deploy to meet the rebel threat, which exposed their fielded forces to NATO air attack. Regardless, NATO airpower was the catalyst in ending ethnic cleansing in Kosovo in 1999.

Mark D. Witzel

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American Volunteer Group

World War II organization of volunteer fliers in China. The American Volunteer Group (AVG), popularly known as the Flying Tigers, grew out of Chinese President Chiang Kaishek's desire for U.S. airplanes and pilots to protect the Burma Road, China's only access route to the outside world. By the fall of 1940, Japanese forces had blockaded the Chinese coast, leaving an unimproved mountainous route from Rangoon, Burma, to Kunming, China, as the beleaguered nation's logistical lifeline. Claire L. Chennault, Chiang's air adviser, prepared a plan for a special volunteer American air unit to guard the road. Supported strongly by Secretary of the Treasury Henry Morgenthau, Chennault's scheme won President Franklin D. Roosevelt's approval in the winter of 1940–1941.

Allocated 100 Curtiss P-40s, Chennault received permission to recruit personnel from the U.S. military services. Officially constituted for service with the Chinese Air Force on 1 August 1941, the AVG began training at Tongoo, Burma, close to Rangoon, in the fall of 1941. By early December, the organization had 82 pilots and 79 aircraft that were formed into three squadrons.

Following the Japanese attack on Pearl Harbor on 7 December 1941, Chennault sent two squadrons to Kunming to protect the Burma Road while one squadron remained in Rangoon to fight alongside the Royal Air Force. The AVG saw its first action on 20 December 1941, when Chennault's fliers shot down six of 10 Japanese bombers over Kunming.

During the early months of 1942, when the news of U.S. losses in the Pacific seemed a litany of despair, the AVG provided the only positive news from Asia. The young airmen, in their shark-nosed P-40s—painting the nose with this fearsome image was an idea borrowed from the RAF in Africa—soon became national heroes in both China and the United States. Thanks in large part to the tactical training provided by Chennault and to an efficient early warning network of ground spotters, AVG pilots scored impressive victories over the Japanese at a time when Imperial forces seemed unstoppable elsewhere.

On 4 July 1942, the AVG was officially demobilized. Recalled to U.S. military service, Chennault became commander of the China Air Task Force. Few of his AVG pilots, however, accepted induction into the U.S. Army Air Forces.

The AVG left behind an impressive record, claiming 296 enemy aircraft shot down (a figure questioned by later authors) and losing only 14 P-40s in aerial combat (with another 72 P-40s lost in accidents or abandoned). Twenty-two Americans were killed or captured; another three individuals died in training accidents.

Romanticized by the media at the time and later, the AVG nonetheless performed superbly under extraordinarily difficult circumstances. But perhaps even more important than any military contribution was their public relations value in the United States during the darkest days of World War II.

William M. Leary

See also

Chennault, Claire L.

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Amet-Khan, Sultan (1916–1971)

Soviet fighter ace and twice Hero of the Soviet Union. Sultan Amet-Khan was born on 25 October 1916 in Crimea in a Tatar family. He completed flight school in 1940. Initially unsuccessful, not until 31 May 1942 would he tally a score, ramming a Ju 88 with his Hurricane fighter. Many successes followed thereafter. In October 1942, he was transferred to the 9 GIAP (Guards Fighter Air Regiment), composed of handpicked pilots and equipped first with the Yak-1, later the P-39L, and finally the La-7. On 24 August 1943 Amet-Khan was named a Hero of the Soviet Union for 19 individual and 11 group victories. During the war, Major Amet-Khan completed 603 sorties and scored 30 individual and 19 group victories in 150 air combats. He was accorded the honor a second time on 29 June 1945. After the war he became a military test pilot. He was killed testing a Tu-16LL on 2 February 1971.

George M. Mellinger

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An Loc, Battle of (1972)

Major battle during the 1972 North Vietnamese Nguyen Hue (Easter) Offensive in which U.S. airpower proved the decisive factor. The Battle of An Loc, the capital of Binh Long Province in the III Corps Tactical Zone and only 65 miles from Saigon, was the southernmost prong of the Nguyen Hue Offensive, which was a large-scale, three-pronged conventional attack launched on 30 March 1972 (the other main communist attacks were aimed at Quang Tri and Kontum). On 5 April, North Vietnamese forces crossed the Cambodian border into the III Corps area of operations. After a feint at Tay Ninh City, the main attack was launched against Lôc Ninh, which was quickly overwhelmed, opening up a direct route down Highway QL-13 to Saigon through An Loc and Lai Khe. After the fall of Lôc Ninh, the North Vietnamese forces, consisting of the Fifth, Seventh, and Ninth Vietcong/North Vietnamese Army Divisions, surrounded An Loc, effectively cutting it off from outside ground reinforcement and resupply. On 3 April, after heavily shelling the city for hours, the North Vietnamese launched a massive infantry attack supported by T-54 and PT-76 tanks from several directions. The North Vietnamese attackers were almost successful in hand-to-hand and house-to-house fighting, but fires from AH-1G Cobra helicopters and continuous tactical air support from U.S. Air Force, Navy, and Marine fighter-bombers and Air Force AC-130 Spectre gunships enabled the defenders to hold out against the initial assault, but not before they were pushed into an area less than a mile square. Another critical factor in the ability of South Vietnamese forces to hold out in this and subsequent attacks was the impact of the B-52 ARC LIGHT missions that ringed the city and precluded the North Vietnamese forces from massing and completely overrunning the besieged defenders. The South Vietnamese suffered repeated ground attacks and round-the-clock heavy shelling, but, aided by U.S. Army advisers and U.S. airpower, they continued to hold ground against overwhelming odds, though sustaining heavy casualties. During the course of the battle, 252 B-52 missions were flown and 9,023 tactical air strikes were carried out. During the siege, which was finally lifted in June, the three attacking North Vietnamese divisions sustained an estimated 10,000 casualties and lost most of their tanks and heavy artillery. South Vietnamese losses were 5,400 casualties, including 2,300 dead or missing. Although An Loc was in ruins, U.S. airpower had proved decisive, and the defenders had blocked a direct assault on Saigon and effectively blunted the North Vietnamese Easter Offensive in the South.

James H. Willbanks

See also

ARC LIGHT; Boeing B-52 Stratofortress; Gunships; Helicopters, Military Use; McDonnell F-4 Phantom II; Vo Nguyen Giap

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Anderson, Orville "Arson" (1895–1965)

U.S. Air Force general and airpower theorist. Orville "Arson" Anderson was born in Springville, Utah, on 2 May 1895. After leaving Brigham Young University before earning his degree, he enlisted in the U.S. Army Signal Corps Aviation Section in August 1917. Commissioned a second lieutenant a year later after completing balloon observer training, Anderson gained renown for participating in the airship flights of *Explorer I* (1934) and *Explorer II* (1935), the latter flight setting an altitude record of 72,395 feet. Anderson graduated from the Air Corps Tactical School (1937) and the Command and General Staff School (1938).

Anderson's initiation in studying and formulating philosophies of airpower began in 1938 when he became the executive secretary to the Air Corps Board at Maxwell Field. Successive assignments during World War II included Chief of Plans Division at Army Air Forces Headquarters (1941–1943), chairman of the Combined Operational Planning Committee, European Theater of Operations (1943–1944), and senior military adviser, U.S. Strategic Bombing Survey (1945–1946). Anderson also served as deputy commander for operations, Eighth Air Force (1944–1945). Promotions merited by Anderson to general-officer grade included brigadier general (1942) and major general (1944).

During World War II, Anderson authored "A Study to Determine the Minimum Air Power the United States Should Have at the Conclusion of the War in Europe" (1943), which promoted a postwar plan dictating that the USAAF be strengthened so as to ensure world peace and stability under U.S. leadership and act as a countermeasure to the superior number of Soviet ground forces. Believing that U.S. ability to win future wars depended mainly on the development of superior technology and superior strategy, Anderson eagerly accepted the assignment of commandant of the Air War College, Maxwell AFB (1946–1950). As commandant, Anderson accentuated the necessity for the continuous integrated development of technology, strategy, and efficient use of military manpower in creating an effective airpower theory. Anderson's tenure as commandant of the Air War College ended abruptly in September 1950, when his comments to a civilian reporter concerning use of atomic weapons against the Soviet Union caused General Hoyt S. Vandenberg, Air Force Chief of Staff, to relieve him. General Anderson retired from military service in December 1950 and died at Maxwell AFB, Alabama, on 23 August 1965.

Mark R. Grandstaff

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Andrews, Frank Maxwell (1884–1943)

U.S. Army lieutenant general and early advocate of offensive airpower. A West Point graduate (1906), Andrews joined the U.S. cavalry as a second lieutenant. He served in the cavalry for 11 years. When the United States entered World War I, Andrews received a transfer to the Aviation Section of the U.S. Army Signal Corps. He received his wings in 1918 and served in various stateside positions, including commander of U.S. flying fields.

In the 1930s, cost-conscious Army leaders advocated purchase of less expensive light and medium bombers such as the B-18 Bolo. Andrews wanted Boeing's four-engine

Model 299 heavy bomber, better known as the B-17 Flying Fortress. To Andrews, GHQ AF was the offensive arm of Army aviation, and he became a vocal proponent of strategic bombardment theories and the acquisition of heavy bombers.

On 30 October 1935, at Wright Field, Ohio, the prototype YB-17 crashed in flames during takeoff. Despite the setback, Andrews persisted, and his vision and determination saved the B-17. He convinced the Army to buy 13 B-17s for experimental purposes. Many called the B-17s "Andrews's Folly," but events of World War II soon proved his wisdom.

Following the January 1943 Casablanca Conference, General Dwight D. Eisenhower made Lieutenant General Andrews commander of the European theater of operations for the Air Corps. Andrews performed his duties with dedication and verve. On the afternoon of 3 May 1943, during an inspection tour, General Andrews's B-24D Liberator, fighting foggy conditions, crashed into a hillside while attempting to land at the Royal Air Force Base at Kaldadarnes, Iceland. Andrews and 13 others were killed. Only the tailgunner survived.

Andrews was buried at Arlington National Cemetery. On 31 March 1949, Andrews Air Force Base, Maryland, was named in his honor. During his career, he received the Distinguished Service Medal, Distinguished Flying Cross, and Air Medal, along with many other decorations and honors.

William Head

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Ansaldo

Italian leader in heavy engineering. The Ansaldo firm was created in 1852 in Genova to grant the Kingdom of Sardinia independence from foreign industry. Named after its general manager, Giovanni Ansaldo (1819–1859), it soon became a shipbuilding and armaments conglomerate and entered the aviation field in 1916. The first contract was for Sopwith Baby floatplanes under license, but the arrival of Giuseppe Brezzi (1878–1958), just released from the army, led to Ansaldo being chosen to build a new fighter type. Designed by army engineers Savoja and Verduzio, and easily recognized by the triangular rear fuselage and "W" arrangement of its wing struts, it was designated the SVA and flew in March 1917. Rejected as a fighter, with its speed and range it made many notable flights, including the 1918 Vienna raid led by Gabriele d'Annunzio (1863–1938) and the 1920 Rome-to-Tokyo flight. It is estimated that about 2,000 single- and two-seat variants were built until 1926.

Ansaldo expanded, building new plants and acquiring the Pomilio firm in Turin. Disagreements over royalties owed to Savoja and Verduzio led Brezzi to introduce new Ansaldo types, starting with the A.1 Balilla fighter that saw little combat in World War I but was used successfully in Poland against the Soviets in 1921–1922.

After World War I, Ansaldo sought markets abroad and in 1920 accounted for two-thirds of all Italian aircraft exports. It also introduced the A.300, a general-purpose biplane used extensively for army cooperation and training. But Ansaldo had overextended itself and was in a difficult financial position. The airframe activities were first concentrated in Turin, then formed into a separate company, Aeronautica Ansaldo, which obtained a license for the all-metal Dewoitine D.1 fighter, building it in the AC.2 and AC.3 variants. In 1925, Aeronautica Ansaldo was sold to Fiat, becoming its aircraft division under the name Aeronautica d'Italia.

Gregory Alegi

See also

Fiat; Italian Aircraft Development

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Antimissile Defense

The use of defensive missiles and other means to destroy incoming missiles. Attempts at antiballistic missile (ABM) defense are almost as old as ballistic missiles themselves, but the daunting prospect of trying to "hit a bullet with a bullet" prevented most attempts from getting beyond the planning stages until the stakes were raised by the advent of nuclear-tipped intercontinental ballistic missiles (ICBMs) in the late 1950s.

In the United States, ABM development continued throughout the late 1950s and 1960s but was slowed due to the daunting technical challenge as well as growing concern, in government and the public, that even if an ABM system could be made to work it would only accelerate the arms race. In 1969, the Sentinel program, with its ambitious goal of city defense, was transformed while still in development into the more limited Safeguard program, aimed now only at protecting a limited number of ICBM fields.

In the Soviet Union, tests associated with its ABM program began as early as 1961, and by 1970 or 1971 the massive Galosh ABM system, built around Moscow, was probably fully operational. In May 1972, the United States and the Soviet Union signed the ABM Treaty, limiting research to the laboratory and allowing each side only two ABM sites of no more than 100 launchers each (reduced to one site in 1974). The U.S. site at Grand Forks, North Dakota, finally became operational in 1975, only to be canceled by Congress that same year; the Soviet system around Moscow continued in operation well into the 1980s.

ABM research continued in both superpowers, however, refueled by Ronald Reagan's dramatic March 1983 announcement of the new Strategic Defense Initiative. Although the so-called Star Wars system has never been deployed, its specter played an important role in the arms race during the last years of the Cold War. In the 1990s, with the advent of precision-guided munitions, the prospect of interceptor missiles that did not have to use nuclear warheads of their own became a realistic possibility for the first time. A very public demonstration of this was the use of U.S. Patriot missiles to intercept Iraqi Scud missiles over Saudi Arabia and Israel. Though later analysis concluded that far fewer of the Scuds may have been destroyed than was initially believed, the Scuds were more of a political and public relations problem than they were a military threat anyway, so in a sense the Patriot missiles accomplished their mission as soon as the media reported that they had. At the turn of the twenty-first century, the ABM controversy showed no signs of abating, as U.S. programs for both theater and national missile defense continued.

David Rezelman

See also

Air Defense Command; Antisatellite Capability; Ballistic Missile Early Warning System; Defense Advanced Research Projects Agency; Distant Early Warning; Missiles, Intercontinental Ballistic; Missiles, Surface-to-Air; North American Air Defense Command; Precision-Guided Munitions; SAGE Defense System; Strategic Arms Limitation Talks; Strategic Defense Initiative

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Antisatellite Capability

The United States first started work on antisatellite (ASAT) systems during the late 1950s. But the threat that these systems were intended to counter—Soviet nuclear weapons orbiting in space—failed to materialize. Because of the limitations of early guidance systems, antisatellite weapons had to use a nuclear warhead, but as the detonation of nuclear warheads would damage U.S. satellites as well, the capability was of questionable military value.

The U.S. Army's Nike-Zeus missile was originally developed as part of an antiballistic missile (ABM) system, but exoatmospheric missiles by definition provided a limited ASAT capability. A limited test series launched eight Nike-Zeus missiles from Kwajalein Island, and the first successful U.S. antisatellite intercept took place on 23 May 1963.

During 1964 the U.S. Air Force deployed several nuclear-tipped Thor launch vehicles that were modified for the antisatellite mission on Johnston Island in the Pacific, and the so-called Program 437 system was tested at least 16 times until its retirement in 1976. Following this the U.S. emphasis shifted to nonnuclear kinetic kill mechanisms.

The ASM-135A antisatellite missile was the primary U.S. ASAT effort during the early 1980s. Launched from a McDonnell-Douglas F-15 Eagle, this two-stage rocket carried a miniature kinetic kill vehicle that used an infrared sensor to home in on the target. A single operational test took place on 13 September 1985 against the Solwind P78-1 satellite, which was destroyed. Political and funding concerns cancelled the program in 1988.

The existing Mid-Infrared Advanced Chemical Laser (MIRACL) located at White Sands Missile Range, New Mexico, is in the process of adapting the laser for use against satellites. In addition to MIRACL, the Pentagon is working on two other ground-based ASATs based on excimer and free-electron lasers. Both technologies could be operational by 2010. The directed energy systems would have the ability to destroy large numbers of satellites in a very short period of time, compared to the kinetic energy ASAT.

Dennis R. Jenkins

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Antisubmarine Warfare (ASW)

ASW seeks to neutralize the fighting capacities of submarines. Strategically, ASW forces accomplish their mission by containing, destroying, or limiting the effectiveness of submarine fleets. Tactically, ASW operations include four components: surveillance and reconnaissance; detection; tracking; and attack and destruction.

Stealth and invisibility are the submarine's greatest allies; it can approach and attack its target without detection. Prenuclear submarines, however, were forced to surface periodically, leaving them vulnerable to discovery and attack.

Military tacticians conceived the idea of using airplanes against submarines before World War I. In 1911, the British Admiralty, acknowledging the potential destructiveness of submarines, appointed a committee to study means for defending against the menace. Lieutenant Hugh Williamson, captain of the British submarine B-3, was one of the officers solicited for ideas. A pilot as well as a submariner, Williamson advocated, in his paper "The Aeroplane in Use Against the Submarine," utilizing flying machines to neutralize hostile submarines.

By Christmas 1914, balloons, airships, and other vehicles were reconnoitering submarines and tracking their movements. Kite balloons and dirigibles proved adept at locating submarines, consequently making their operations more hazardous and less productive. Within a few months, aircraft armed with small bombs were attacking submarines and inflicting damage. It was not until September 1916 that an airplane succeeded in sinking a submarine operating in open sea. Nonetheless, airplanes received substantial ASW duty, and by 1917 patrol aircraft were a fixture in Allied convoys traveling the Atlantic and Mediterranean.

Military strategists drew three lessons from World War I airborne ASW. First, they discovered that any air presence, irrespective of its size, was better than none at all. As Williamson predicted, aircraft exerted the greatest pressure on submarines by forcing them to submerge, denying them the tactical advantage and thereby neutralizing them. The second lesson was that aircraft needed a dependable detection device if they hoped to fully participate in ASW. Finally, military officials concluded that antisubmarine aircraft needed technological advances in aerodynamics, weaponry, and telegraphy.

The outbreak of World War II saw the Royal Air Force, the U.S. Naval Aviation Corps, and other agencies responsible for aerial ASW ill-equipped for their missions. Budgetary constraints left admirals and generals little money to test and equip their airplanes with radar, sonar, and other antisubmarine innovations. Few planes were equipped with ship-search radar, sonar, or hydrophones. Most planes continued to use bombs, bombsights, and bomb-release gear that were substandard or obsolete.

During World War II, airborne ASW evolved into a substantial threat as a result of advances in tactics, aircraft, submarine detection, and weaponry. Better coordination between patrol aircraft and convoy vessels increased the efficiency of both, and new long-range machines and aircraft carriers allowed for longer and wider surveillance and reconnaissance. Strategic bombing wreaked havoc on submarine pens, yards, and installations. Radar, sonar, and magnetic airborne detection (MAD) enabled airplanes to locate and track submarines. Air-dropped depth charges and homing torpedoes permitted air units to more easily destroy their prey.

Yet by war's end, submarines had evolved sufficiently to thwart their airborne antagonists. Fast snorkel boats like the German Type XXI were practically impervious to airborne radar and MAD gear, again leaving aircraft without effective means to detect submarines. Technically, if not militarily, submarines emerged from the war victorious.

Even today there is no single detection device capable of leading an aircraft to a submerged submarine. Modern ASW aircraft rely on a combination of radar, sonar, and magnetic, exhaust-trail, and infrared detectors to pinpoint the location of vessels. Onboard computers enable pilots to process data drawn from these various sensors. Once they have found their prey, aircraft employ acoustic homing torpedoes, guided missiles, and rockets to deliver the mortal blow.

With silent, nonmagnetic submarines on the horizon, the future of aerial ASW poses significant challenges. Detection sensors and ordnance currently available seems powerless against vessels operating several miles beneath the surface. Yet despite these limitations, aircraft retain the speed, flexibility, and elusiveness that have traditionally made them dangerous to submarines. Aircraft will continue to operate as a destructive platform and, perhaps more important, as a constraining force whose mere presence restricts submarines to innocuous movements near the ocean floor.

Daniel E. Worthington

See also

Aerial Torpedoes; Balloons; Flying Boats; Helicopters, Military Use; Magnetic Airborne Detection; Radar; Sikorsky, Igor I.; World War I Aviation; World War II Aviation

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Antonov Aircraft

Soviet aircraft design bureau specializing in military transport aircraft. Oleg Konstantinovich Antonov was born in Moscow in 1906, and from 1923 through the 1930s he specialized in the design and construction of gliders. During World War II, he was assigned to the Yakovlev bureau. He established his own Antonov design bureau in Siberia in 1946, relocating almost immediately to Kiev. The Antonov An 2 appeared in 1947. Although it was ridiculed in the West for its seemingly outdated biplane configuration, it proved well-adapted for its role as a civilian and military light transport capable of operating from undeveloped fields, carrying a dozen passengers.

When production ended in 1992, a total of 17,400 An 2s had been built in the Soviet Union and Poland, plus another 1,500 in China. A more modern design, the An 8, appeared in 1958, a twin-engine, high-tail, shoulder-wing transport similar in concept to the Lockheed Hercules. After a short production run, two larger four-motor derivatives, the An 10 civilian airliner and the military An 12, appeared. The An 12, was even more like the C-130 and was capable of carrying light armored vehicles or 100 paratroops. Notable was the presence of a gun turret in the tail, present even on most civilian examples. With 1,265 examples produced, it became the Soviet Union's main transport and was widely exported.

During the period 1962–1992, Antonov also produced the An 24, An 26, An 30, and An 32 twin-motor, high-wing transports, all bearing more than a family resemblance, each optimized for slightly different functions, from feeder airliner to light cargo aircraft to aerial survey. Although the An 30 and An 32 were produced in small series, some 1,400 examples each of the An 24 and An 26 each were produced, and both were widely exported. Only 66 of the huge An 22s, with four contrarotating turboprops, were produced from 1965 to 1975; this aircraft was capable of transporting Scud missile launchers or two T-55 tanks and remains in limited service. Its successor is the An 124, a four-turbofan transport in the class of the C-5A and capable of lifting 150 tons.

A stretched variant of the An 124, with six fan-jet engines and a twin tail, is the An 225, the largest (except for the Hughes Hercules flying boat) and most powerful aircraft ever built. This aircraft was designed specifically for piggyback transport of the Buran space shuttle. With the termination of the Russian shuttle program, the single An 225 has been grounded. The new generation of Antonov transports is the An 72 and An 74 family, with twin jets mounted over the shoulder-high wings. These transports have been in limited production from the late 1980s for both Russia and Ukraine.

George M. Mellinger

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ANVIL (1944)

Allied code name for invasion of southern France on 15 August 1944. Other commitments limited air support until 5 August, when the Mediterranean Allied Air Forces (MAAF) began hitting Luftwaffe bases, lines of communications, and coastal defenses. To hide the location of the landings, MAAF struck four potential beaches. The limited supply of ammunition for the naval guns made airpower even more important in the preassault bombardment. MAAF effectively interdicted German movements, but clouds hampered the final prelanding bombardment.

Grant Weller

See also

Mediterranean Theater of Operations

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Anzio, Battle of (1944)

The Allies' attempted end run, launched on 22 January 1944, to outflank the Germans' Gustav Line in Italy. The Wehrmacht's fierce resistance at Cassino occasioned the Allied decision to execute an amphibious landing farther up Italy's Tyrrhenian coast. As early as 13 January the XII Bomber Command and XII Air Support Command (XII ASC; later redesignated XII Tactical Air Command, or XII TAC) began preparatory attacks ranging from central Italy to the coasts of France. Units of the Fifteenth Air Force (Fifteenth AF) also participated. Employing every type of aircraft from Curtiss P-40 and North American A-36 fighter-bombers to Boeing B-17 and Consolidated B-24 heavy bombers, USAAF fliers pounded Axis airfields, railroads, road junctions, bridges, and targets of opportunity. Simultaneously they engaged Axis aircraft (almost entirely German) over Anzio's environs in a largely successful battle for aerial superiority.

At the assault's beginning on 22 January 1944, "nearly the entire Twelfth Air Force [was] dedicated to supporting the invasion." In addition, the Fifteenth AF dealt the Luftwaffe a severe blow by heavily bombing its airfields and repair facilities in the Po Valley on 30 January. Nevertheless, Allied forces failed to break out immediately. Taking advantage, German forces savagely counterattacked the beaches on 16 February. In response, XII ASC and Fifteenth AF flew more than 250 fighter and fighter-bomber sorties to help stem the German advance.

More than 800 Fifteenth AF bomber sorties (North American B-25s, in addition to B-17s and B-24s) followed the next day, not counting continuing attacks by single-engine aircraft even as the Luftwaffe's Messerschmitt Bf 109s and Focke-Wulf Fw 190s flew approximately 80 combat sorties of their own in close support of the German assaults.

The Allies' furious pace sustained itself to the end of the critical phase of the German attacks on 20 February.

Then three months of sustained positional warfare followed, as the beachhead remained contained by the German Fourteenth Army. Throughout the period, Allied airpower harassed German forces and attempted to keep the pressure off the beleaguered U.S. VI Corps. When the breakout finally did occur in May, Allied airpower played a key part. Strikes by XII TAC aircraft hit German lines of communication southeast of Rome, long-range artillery positions, and supply dumps. The railroad running northwest from the key local objective of Cisterna was repeatedly bombed and strafed, as were German gun positions around VI Corps's perimeter. Heavy bombers of 15th AF were tasked to hit Velletri and Sezze while a forward air controller attached to VI Corps HQ directed fighter-bombers to targets of opportunity. Despite overcast conditions on D-Day (23 May), XII TAC fighter-bombers flew 722 sorties on that day alone. Overall, Mediterranean Allied air force aircraft executed more than 73,000 effective sorties and dropped some 51,500 tons of bombs during Operation DIADEM, the simultaneous attacks on the Gustav Line and the breakout at Anzio. Twelfth Air Force alone was credited with destroying more than 6,500 motorized vehicles, tracked and wheeled, during the period.

D. R. Dorondo

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Apollo Space Program

In 1961, President John F. Kennedy issued a public challenge that called for the United States to land a man on the moon before the end of 1969. Thus began a crash course designed in part to respond to repeated Soviet successes in space. Although the manned aspect of the challenge first involved the Mercury and Gemini programs, it also called for the investigation of lunar conditions and the construction of a rocket capable of reaching the moon. Thus, the existing Project Lunar Orbiter was modified to serve the needs of Apollo by measuring radiation and photographing the moon closely. Five such missions were launched by 1967; in parallel, seven Surveyor missions were sent to land on the moon (two failed), thereby providing critical information to Apollo planners.

In the meantime, a lunar vehicle had to be designed from scratch. Several formulas existed on paper for a lunar landing, each with advantages and shortcomings that depended on the number of passengers, the weight requirements, and what kind of vehicle would land on the moon. Eventually, the National Aeronautics and Space Administration (NASA) approved a new rocket, the massive Saturn V, with a three-man command module, which was developed and built by North American Aviation (later Rockwell). The command module was attached to a service module that contained all fuel, maneuvering rockets, and oxygen supplies. Above the capsule, an escape tower was installed for use during the launch phase of the flight. Although tested multiple times from 1964 onward, the capsule required modifications following a tragic accident during a ground test on 27 January 1967, when the crew of Apollo-Saturn 204 (a training mission later renamed Apollo 1) died on the launchpad at Cape Canaveral during a simulated flight.

Eighteen months later, in October 1968, Apollo 7, the first manned mission, went into earth orbit. By then engineers at the Grumman Corporation were feverishly solving last-minute problems on the Lunar Module (LM), which was to serve as the landing vehicle. The strange shape of the contraption belied its extreme complexity, which involved the use of two engines in nonatmospheric conditions, guidance thrusters, and a landing gear that was light yet sturdy. When the details were finally settled, the LM was to take two of the three astronauts to the lunar surface.

In December 1968, Apollo 8 orbited the moon for the first time. Three missions later, Apollo 11 successfully landed Neil Armstrong and Edwin Aldrin on the moon on 21 July 1969 (Michael Collins piloted the Apollo command module). Another six missions were launched, five of which were successful (Apollo 13 almost ended in disaster, but its crew returned safely to earth). The technical achievement of the Apollo program was stupendous and represented the culmination of technical efforts that dated back to the German rocket program in World War II. However, the splendid achievement happened amid turmoil over the ongoing Vietnam War, rising social problems, and a declining economy, all of which prompted President Richard Nixon to scale back the program. Consequently, Apollo 17 became the last mission to the moon.

Apollo command modules were used, however, in the linking with the Skylab space station in 1973 and with a Soyuz capsule in 1975. Two completed Saturn V rockets remained unused, however, and have since become exhibits at NASA's Johnson and Kennedy Space Centers. The Apollo program did demonstrate a mastery of technocratic planning, but it failed to establish a clear legacy on which NASA could effectively build future programs. Consequently, such projects as the Space Shuttle faced considerable delays and troubles due to lack of direction from the White House and Congress.

Guillaume de Syon

See also
Gemini Project; Mercury Space Program

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Arado Ar 234 Blitz

The world's first jet bomber. The Blitz (or Lightning) entered Luftwaffe service early in 1945, having already served in a reconnaissance role. More than 200 of the twin-jet aircraft were manufactured, but because of fuel shortages and transportation problems, perhaps half actually reached combat units. Development began in late 1940, with the first prototype completed by 1943. The Junkers Jumo turbojets had developmental problems that, in turn, delayed the Ar 234's maiden flight until 15 June 1943. Because of its narrow fuselage, with inadequate room for retractable landing gear, early versions took off on a trolley that was jettisoned as the plane lifted off. Later the wheels themselves were jettisoned. Additional prototypes flew later in 1943 with larger BMW engines. The B models of 1944 had traditional landing gear and first flew on 10 March 1944. Initial reconnaissance missions took place in the summer of 1944. The C models in production at the end of the war used four engines (in paired nacelles) rather than two. In all, more than 30 experimental models were built, but operations came too late to have any effect on the war. The only surviving example, a B model, is in the National Air and Space Museum in Washington, D.C.

Christopher H. Sterling

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ARC LIGHT

Code name and general term for the use of B-52 Stratofortress bombing missions to support ground tactical opera-

The world's first operational jet bomber was the slender, fast Arado Ar 234. Highly effective, it was built in small numbers and too late to affect the outcome of the war. (Walter J. Boyne) tions, to interdict enemy supply lines in Vietnam, Cambodia, and Laos, and later to strike targets in North Vietnam. In 1964, the U.S. Air Force began to train strategic bomber crews in the delivery of conventional munitions. Under Project Big Belly, all B-52Ds were modified so that they could carry nearly 30 tons of conventional bombs. B-52s were deployed to air force bases in Guam and Thailand. ARC LIGHT operations were most often close air support bombing raids of enemy base camps, troops concentrations, and/or supply lines.

They were used for the first time in support of troops in contact during the Battle of the Ia Drang Valley in November 1965. Releasing their bombs from 30,000 feet, the B-52s could neither be seen nor heard from the ground as they inflicted awesome damage. B-52s were instrumental in breaking up enemy concentrations besieging Khe Sanh in 1968 and Pleiku and An Loc in 1972.

The two most famous B-52 operations were LINEBACKER and LINEBACKER II. President Richard Nixon ordered LINEBACKER to stem the tide of the North Vietnamese Army's 1972 Easter Offensive. In December 1972, Nixon ordered LINEBACKER II, the so-called Christmas bombings. During this operation, B-52s bombed Hanoi and Haiphong to force North Vietnamese negotiators back to the table at the Paris peace talks.

Between June 1965 and August 1973, 126,615 B-52 sorties were flown over Southeast Asia. During those operations, the U.S. Air Force lost 31 B-52s: 18 from hostile fire over North Vietnam and 13 from operational causes.

James H. Willbanks

See also

An Loc, Battle of; Boeing B-52 Stratofortress; Cambodia Bombings; Khe Sanh; LINEBACKER I; LINEBACKER II

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Argentine Aircraft Industry

Recent decades have been difficult for Argentina, formerly a prosperous and modernizing nation now struggling to preserve its industrial base. Lockheed Martin seems to have assured a continuing aeronautical tradition by acquiring, from Argentina's privatizing government, Latin America's oldest aircraft factory (dating from 1927) in the industrial city of Cordoba.

From Argentina's earliest powered flights in 1910, the simple airplanes of the era were constructed locally. European advances were closely linked to Buenos Aires via ample steamship connection and plentiful immigration from Italy and elsewhere. World War I was a disruption, but a new stream of aircraft and airmen began arriving in 1919.

Growth in population and wealth reached a peak in the 1920s, and the Fabrica Militar de Aviones (FMA; Military Aircraft Factory) was inaugurated by the government in 1927. License production of engines and aircraft commenced, with the British-designed Avro 504-J and Bristol F.2B and the French Dewoitine D.21 fighter being the initial products. Many indigenous designs followed.

A great variety of military and civil aircraft would be built over the years. A spectacular era occurred after World War II, as European talent once again refreshed Argentine airpower. Kurt Tank, designer of the Luftwaffe's formidable Focke-Wulf Fw 190 fighter, built five examples of his swept-wing jet design, as the IA-33 Pulqui II. The IA-27 Pulqui I had been a basic straight-wing jet prototype. Examples of these and other national designs are preserved in Argentine museums.

Many British military aircraft were imported after World War II and, later, U.S. aircraft, after diplomatic relations improved (Argentina was pro-Nazi until 1945). The FMA in Cordoba constructed transports, trainers, and light aircraft; foreign as well as domestic designs were assembled. But the old factory lost some of its earlier prominence as the nation's economic problems limited its business. Restricted funding came with political change after Argentina lost the 1982 Falklands War with Great Britain.

Plans to link up with the expanding Brazilian light airliner business failed to mature. Development of the Condor 500-mile-range missile also ended. Lockheed Martin, which in 1995 negotiated a 25-year lease on the Cordoba facilities, with further extension foreseen, was a welcome newcomer. Meanwhile, Argentina had supported the U.N. Coalition during the 1991 Gulf War. With Argentina's foreign policy aligning with NATO, a desperately needed upgrade to the nation's air force came in the form of the Douglas A-4AR "Fighting Hawk." Argentina had flown similar A-4 Skyhawks in the 1982 Falklands War, but the aircraft of 15 years later are remanufactured with modern controls and systems by Lockheed Martin in Cordoba.

Meanwhile, several FMA products that had languished have found new life. The IA-63 Pampa jet trainer, begun in 1979 in collaboration with Germany's Dornier, is again on the market, now supported by a reinvigorated plant. The IA-58 Pucara, used during the Falklands conflict, may again be built in small numbers. The AMX light fighter-bomber, a joint project with Aermacchi, may also see more production due to the type's success in the Balkans with the Italian air force.

Many developing nations are attempting to initiate aviation industries to supply local needs and to boost technological levels. Argentina is a different case, with a substantial tradition of aircraft manufacture. It appears that Cordoba will continue to be one of the more important centers of airpower in the Southern Hemisphere for years into the future.

Gary Kuhn

ARGUMENT (BIG WEEK, 1944)

BIG WEEK, formally known as Operation ARGUMENT, was the Allied code name for a coordinated assault in February 1944 upon German fighter factories and ball-bearing works located in Germany, Austria, and occupied Poland. These attacks were mounted by the U.S. Eighth Air Force flying from England and the U.S. Fifteenth Air Force flying from Italy. Daylight raids by U.S. bombers were supplemented by Royal Air Force area-bombing by night. Operation ARGUMENT sought to disrupt fighter production, compelling German fighters into the air where they could be destroyed. Only thus could German airpower be defeated and the success of the forthcoming Allied invasion of the continent be assured. Air superiority, the key goal of this offensive, could not have been achieved without the long-range North American P-51 Mustang fighter that escorted U.S. bombers to their targets.

For this attack, U.S. Strategic Air Forces in Europe massed 1,180 operational B-17 and B-24 bombers, as well as 676 operational P-47, P-38, and P-51 fighters. The German defensive force comprised 350 Fw 190 and Bf 109 fighters, 100 twin-engine Me 110, 210, and 410 machines, and 50 night-fighters. Armed with 210mm rockets, the twin-engine fighters were the worst threat to U.S. bombers.

Hammer blows fell upon Messerschmitt plants at Regensburg, Leipzig, Augsburg, and Gotha. Focke Wulf factories were hit at Kreising, Tutow, and Posen. Ball-bearing works at Schweinfurt, Stuttgart, and Steyr were pounded. Bad weather brought BIG WEEK to an end after 25 February.

The Americans lost 227 bombers (5.9 percent), and the RAF lost 157 (6.7 percent); 42 U.S. fighters were also lost.

The Germans lost an estimated 700 fighters in production, and 232 aircraft awaiting delivery were destroyed. Luftwaffe Quartermaster's documents conceded that 282 fighters were shot down. The twin-engine force was decimated. Although increased German efforts could produce more fighters, the 100 veteran pilots and combat leaders killed during BIG WEEK were irreplaceable.

The task begun during Operation ARGUMENT would be completed with attacks on Berlin in March and strafing of German airfields in April and May, ensuring Allied air superiority for the Normandy invasion on 6 June 1944.

Sherwood S. Cordier

See also

German Air Force (Luftwaffe); North American P-51 Mustang; Spaatz, Carl Andrew; Strategic Bombing

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Armstrong, Neil A. (1930–)

U.S. test pilot and astronaut. Armstrong was born in Wapakoneta, Ohio, on 5 August 1930. Upon receiving a scholarship from the U.S. Navy, he enrolled at Purdue University and began studies in aeronautical engineering. In 1949, the Navy called him to active duty. During the Korean War, he served as an aviator and flew 78 combat missions while assigned to the aircraft carrier USS *Essex.* By 1955, Armstrong completed his bachelor of science degree at Purdue and became a research pilot for the National Advisory Committee for Aeronautics (NACA) and then its successor, the National Aeronautics and Space Administration (NASA). In 1962, he piloted the X-15 rocket plane to an altitude of 207,500 feet and to a speed of 3,765 mph.

Later in 1962, he was selected with the second group of astronauts. His first space flight occurred in March 1966 aboard Gemini 8. He and fellow crewmate David Scott reached earth orbit and achieved the first successful docking with another spacecraft. Shortly after docking with the Agena target vehicle, both spacecraft began to tumble wildly. Though he was successful in disengaging from the Agena, a stuck thruster on the Gemini vehicle forced Armstrong to make an emergency landing in the Pacific Ocean. In January 1969, he was chosen as crew commander of Apollo 11. On 16 July 1969, Armstrong, along with Buzz Aldrin and Michael Collins, rode a Saturn 5 rocket to the moon. He and Aldrin descended to the moon's surface in the Lunar Module *Eagle.* Hours later, Armstrong became the first human to step onto the lunar surface.

After returning to earth, Armstrong held the position of NASA deputy associate administrator for aeronautics (1970–1971) and a professorship at the University of Cincinnati (1971–1979). Currently, he is chairman of AIL Technologies, Inc., and sits on many other corporate boards.

Mark E. Kahn

A great test pilot and the first man to walk on the moon, Neil Armstrong pats the X–15 with respect, knowing it was the most advanced test aircraft in the world. (NASA)

See also

Apollo Space Program; Gemini Project; National Aeronautics and Space Administration; North American X-15

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Armstrong Whitworth Aircraft

British aircraft manufacturer. Like several aircraft firms in Great Britain and in Germany, Armstrong Whitworth descended from local shipbuilding firms. It entered aviation initially with the manufacture of aircraft engines and propellers. It launched into aircraft design and manufacture in 1913, its efforts enhanced by the acquisition of Frederick Koolhoven as a designer.

During World War I, the principal contribution by Armstrong Whitworth to the war effort was the FK.8 (the "Big Ack"), of which 1,652 were built by 1918. A reconnaissance aircraft, the FK.8 (the letter designation deriving from the initials of the designer) proved to be a major improvement over the earlier Royal Aircraft Factory BE.2c observation planes in which so many Royal Flying Corps crews were sacrificed. The FK.8 proved to be versatile, performing well in the ground attack and bombing roles as well as the usual tasks of an observation plane.

After the war, the firm was reorganized into two firms, Armstrong Siddeley Motors and Sir W. G. Armstrong Whitworth Aircraft. It was able not only to survive but also to prosper during the interwar years with the introduction of two biplanes powered by radial engines. The first of these was the Siskin, a delightfully aerobatic aircraft that was the star of the Hendon Displays. Aesthetically displeasing, the Siskin in its later models offered a 156 mph top speed and superb maneuverability. The Royal Air Force purchased 485 of them at a time when most manufacturers were fighting for orders.

Its sibling was the equally plain-looking Atlas, an army cooperation aircraft that replaced the aging Bristol fighters that many RAF units still flew. Like the Siskin, the Atlas was of metal construction with fabric covering and retained the fixed-pitch propeller attached to an uncowled radial engine, fixed landing gear, and open cockpits. The Atlas remained in production until 1933, with 446 being purchased. Armstrong Whitworth was thus well positioned to compete for the new orders that were on the horizon because of the threat of war.

The firm made a complete departure from past practice with its next aircraft, the famed Whitley. It was of all-metal, stressed-skin construction and had well-cowled engines, an enclosed cockpit, and retractable landing gear.

The Whitley did well early in World War II as a bomber but was soon relegated to other duties when the four-engine bombers came on the scene and Armstrong Whitworth was tasked to build Avro Lancasters. It continued to build other manufacturer's designs after the war, including the Hawker Sea Hawk and Gloster Meteor. The only company products to reach production were the Argosy freighters, of which 72 were built. After a series of mergers, the name disappeared when it became part of Hawker-Siddeley Aviation in 1965.

Walter J. Boyne

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Arnold, Henry H. "Hap" (1886–1950)

Pioneer U.S. military aviator and later the general who had primary responsibility for building the most powerful air force of any combatant nation during World War II.

Henry H. Arnold was born on June 25, 1886, into a family that had a long tradition of military service. Following graduation from West Point in 1907, he spent two years in the Philippines until returning to Governors Island, New York, were he observed flights by the Wright brothers, Glenn H. Curtiss, and other early pilots. Arnold soon volunteered for flight training, which he successfully completed in 1911.

Over the next few years he served as a stunt flier in several movies, and on June 1, 1912, at College Park, Maryland, he established an altitude record of 6,500 feet in a Model B Wright biplane, a feat that earned him the first MacKay Trophy, presented annually thereafter for the most meritorious accomplishment in military aviation.

At the outbreak of World War I, Arnold was recalled from the Panama Canal Zone, where he had organized the 7th Aero Squadron, to Washington to head the information office of the Aviation Section of the U.S. Army Signal Corps. Rising swiftly in rank, he became the youngest full colonel in the U.S. Army. He asked for and received a combat assignment but never realized it because of illness.

During the immediate post–World War I years, Colonel Arnold served in a variety of supervisory positions in California, culminating as commanding officer of Rockwell Field, San Diego. Because of his continuing support of Brigadier General Billy Mitchell, who had angered the War Department with his constant badgering to gain public support for a separate air force, Major General Mason Partrick, chief of the Air Service, "exiled" Arnold to Fort Riley, Kansas, in February 1926.

Back in favor in the redesignated U.S. Army Air Corps and after graduating from the Command and General Staff College at Fort Leavenworth, Kansas, in 1929, Arnold completed a two-year tour at Wright Field, Ohio. Then he received one of his most important career assignments: as commanding officer of March Field, California, where he experimented with squadron fighter tactics, cargo airlift operations, and long-range bombing missions that helped estab-

The first—and to date only—General of the Air Force, Henry H. "Hap" Arnold. He literally worked himself to death in the service of his country. (George M. Watson, Jr.).

lish operational procedures used by the U.S. Army Air Forces during World War II.

During the early 1930s, Colonel Arnold sought every opportunity to publicize the Army Air Corps and the role of airpower in war. He addressed civic gatherings and luncheons, attended fairs and rodeos, and developed a close rapport with many Hollywood producers and movie stars. He also made lasting friendships with members of the scientific community at the California Institute of Technology, including Dr. Theodore von Kármán, the renowned aerodynamicist.

In 1934, Arnold was called to Washington to lead a flight of 10 B-10 bombers from Washington to Alaska and back, a round-trip of 7,630 miles. The successful flight won Arnold an invitation to the White House from President Franklin D. Roosevelt, a second MacKay Trophy, as well as his first star and a new assignment as commander of the 1st Wing, General Headquarters Air Force, located at March Field. He was back in Washington in less than a year as assistant chief of the Air Corps, a position he held until September 1938, when he became chief, succeeding Major General Oscar Westover, who was killed in a plane crash.

As the Nazi onslaught dismembered Europe, General Arnold recognized that existing and proposed air bases would not be able to handle the pilot training load, so he turned to civilian flying schools to provide primary instruction. By December 1941, some 40 schools were managing the Army Air Forces' entire primary flight training program, freeing military installations to concentrate on advanced flight instruction.

General Arnold also devised a plan to establish airfields and weather stations in Greenland (April 1941) and Iceland (July 1941). The significance of these bases, whose construction was originally criticized because they were thought to be vulnerable to enemy attack, was best expressed by General Dwight D. Eisenhower. Arnold's plan, he said, "enabled us to send thousands of fighter planes to Europe under their own power, thus saving enormous sums of money that would have had to be put into shipping to transport them."

Several months after Germany launched World War II, on September 1, 1939, Arnold formally requested permission to contract for studies to build a very-long-range bomber. This aircraft, later designated the B-29 Superfortress, would perform spectacularly in the war against Japan.

Throughout World War II, General Arnold and General George Marshall, Army Chief of Staff, worked closely on matters affecting the USAAF. Arnold's unrivaled knowledge of the USAAF, and his long personal friendship with Marshall, helped both men. As the war proceeded, both agreed that establishing an independent air force ought to await the end of the conflict.

Arnold was known for driving his subordinates hard, but he also drove himself hard. During the war he suffered two heart attacks; the first in May 1943 prevented him from attending the third Washington Conference. His second heart attack struck him down in March 1945 and prevented him from attending the Malta Conference between British and U.S. officials and the Yalta Conference, which also included the Russians. He was on his feet in less than a month when he flew to Europe to visit his commanders and General Eisenhower.

In May 1945, Arnold turned his attention to the war in the Pacific and visited the Marianas, observing the B-29 squadrons and reviewing the strategic air campaign against Japan. After a B-29 dropped the first atomic bomb on Hiroshima, Japan's capitulation soon followed. Arnold retired on March 1, 1946, and left Washington for his ranch at Sonoma, California, where he worked on his memoirs, *Global Mission.*

Honors followed Arnold's retirement. Congress promoted him to the permanent five-star grade of General of the Army in 1946, and in May 1949 President Harry Truman awarded him the permanent five-star rank of General of the Air Force. His greatest reward came in 1947 with the passage of the National Security Act, which established the U.S. Air Force as an independent service arm—a goal Arnold and his commanders had long sought. He suffered three more heart attacks; the last one, on January 15, 1950, was fatal. Robert A. Lovett, the wartime assistant secretary of war for air, eulogized Arnold at the burial ceremony at Arlington National Cemetery, stating that he was as much a casualty of the war as if he had been severely injured in the line of duty.

George M. Watson Jr.

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Artillery Spotting

One of the primary missions in the early history of air warfare. Aviation's most important use during World War I was reconnaissance, and on the Western Front, reconnaissance's biggest subdivision was artillery regulation.

Spotting was still done the old-fashioned way, by climbing a hill and looking through binoculars, but to this tried-and-true method balloons and airplanes were added. Both corrected fire by telling batteries whether shots were falling long or short, left or right of the target, using a sectioned circle aligned with local maps to further pinpoint the references.

Balloons kept in touch by telephone, but airplanes employed less exact means. Visual techniques were used, the airplane signaling by light flashes or flares, the battery "talking" back via large, white cloth letters laid on the ground. One-way wireless was also employed, the aircraft being able to tap out Morse messages to a receiver on the ground but being unable to receive itself. As transmitters required a weighted wire antenna that had to be reeled in if attacked (or in any case before landing), this method had a downside. Improvements in aviation and in radio technology changed things dramatically by World War II, eliminating these primitive methods, but the basic idea of the "spotter" as the artilleryman's eye in the sky remained important.

James Streckfuss

See also
Balloons; World War I Aviation

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Atlantic, Battle of the (1940–1945)

The critical campaign to secure the transoceanic link between Europe and the Western Hemisphere. Winning the Battle of the Atlantic ensured the Allies' ability to project their greater strategic power onto and over the continent of Europe and the Mediterranean. Only thus could the European Axis powers be defeated; but airpower over the Atlantic was not unique to World War II. As early as 1918, fully 685 aircraft and 103 airships of the Western Powers had patrolled the Western Approaches and the Narrow Seas. By 1939, airpower's role in an Atlantic war had only grown. Adolf Hitler's Kriegsmarine (Navy) constituted a genuine threat to the Allies' survival.

The Kriegsmarine exhibited dash, aggressiveness, and technical proficiency, particularly regarding naval gunnery and in the U-boat service. By contrast, the Seeluftstreitkräfte (Naval Air Force) remained a miniscule, largely land-bound stepchild subordinated to the Luftwaffe. Nevertheless, 13.4 percent of all Allied vessels sunk in the Atlantic fell prey to German airpower. The X Fliegerkorps (Air Corps) in Norway and Kampfgeschwader 40 (40th Bomber Wing) on the Atlantic Coast of France demonstrated particular proficiency in attacks on shipping. The latter unit employed, among other types, the Focke-Wulf Fw 200 Condor, a long-range reconnaissance bomber famously called the "scourge of the Atlantic" by Winston Churchill for its deadly efficiency between 1940 and 1942. The X Fliegerkorps operated aircraft such as the Junkers Ju 87 Stuka dive-bomber and Ju 88 and Heinkel He 111 torpedo-bombers. Heinkel also supplied the rugged and versatile He 115 twin-engine torpedo-bomber/floatplane.

Before U.S. entry into the war, Great Britain responded to Germany's Atlantic threat with vigor. Eventually four groups of RAF Coastal Command were activated under the British Admiralty's operational control. Coastal Command patrolled inshore waters flying standard RAF types such as Bristol Beaufort and Beaufighter torpedo-bombers. Besides early models of the Boeing B-17 Flying Fortress and the remarkable Consolidated B-24 Liberator (also flown by the Royal Canadian Air Force), Coastal Command employed the Short Sunderland flying boat, whose 20-hour endurance and heavy defensive armament earned it the German nickname "Flying Porcupine."

Complementing Coastal Command, the Royal Navy's far-ranging carriers embarked Fairey Swordfish, Albacore, and Barracuda torpedo-bombers. British combat air patrol pilots manned Gloster Sea Gladiator biplanes, and, later, Fairey Fulmars, Hawker Sea Hurricanes, and Supermarine Seafires. Supplementing these fighter aircraft were Grumman F4F Wildcats ("Martlets" in British service) and F6F Hellcats. Chance-Vought F4U Corsairs entered the Royal Navy's inventory later. As events demonstrated, the Royal Navy's organic airpower, though limited in strength compared to the U.S. Navy's, proved crucial not only in helping drive the Kriegsmarine's surface raiders from the North Atlantic—especially apparent in the sinking of the battleship *Bismarck*—but also in defeating the submarine menace during the period 1943–1945. In addition, the U.S. Navy, though officially neutral, became increasingly active in the war in, and over, the Atlantic. The USS *Long Island,* the U.S. Navy's first escort carrier (eventually designated CVEs), was commissioned on 2 June 1941 with the potential aim of providing air cover for the so-called midocean gap lying beyond the effective range of shore-based antisubmarine patrols. Later the USS *Wasp* ferried 30 Curtiss P-40 Warhawks to Iceland on 25 July to protect that vital North Atlantic way station. After December 1941, U.S. coastal antisubmarine sweeps flown by Consolidated PBY Catalina patrol-bombers and, occasionally, blimps proved of limited effectiveness. Nevertheless, the U.S. Navy increased the pressure against the U-boats even while fighting a two-ocean war. Only the CVEs in U.S. and British service, however, would truly succeed in bringing airpower effectively to bear against the sub-

While bombers could be flown across the Atlantic routinely, it was more expeditious to deliver fighters by ship, and carriers were sometimes pressed into service to do so. Here Lockheed P-38s and Curtiss P-40s get a helping hand across the sea. (U.S. Navy)

marines. Embarking between six and 30 aircraft, these "baby flattops" formed the core of hunter-killer groups beginning in mid-1942. Using "Huff Duff" high-frequency direction-finding, Leigh lights, homing torpedoes, and fin-stabilized depth charges as well as machine guns and cannons, the group's pilots attacked the U-boats with increasing effectiveness. The fliers' principal aircraft were Grumman TBF/TBM Avenger torpedo-bombers supported by Wildcats. During 1944 the U.S. Navy's hunter-killer groups claimed 16 U-boats destroyed, another 17 being credited to aviators of the Royal Navy. By war's end, some 63 German submarines had been sunk by U.S. Navy aircraft.

In the Mid-Atlantic and South Atlantic, too, airpower proved crucial to Allied success. For Operation TORCH, the U.S. Navy supplied one fleet and several escort carriers embarking Wildcats and Avengers to support the landings of early November 1942. In addition, the escort carrier USS *Chenango* ferried the Warhawks of the USAAF's 33rd Fighter Group to Morocco for operations ashore. Farther south a midocean barrier centered on Ascension Island. There U.S. Navy Consolidated PB4Y-1 Privateers helped prevent marauding German surface raiders and submarines from causing havoc in the southern shipping lanes, including the ferry route for aircraft from eastern Brazil to Takoradi on the Ghanaian coast.

D. R. Dorondo

See also

Fleet Air Arm; United States Navy, and Aviation

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Atomic Bomb

Weapon developed by the United States to end World War II. In August 1939, prominent American scientists headed by Albert Einstein wrote to warn President Franklin D. Roosevelt that scientists in Nazi Germany were conducting experiments to purify uranium-235 (U-235), an essential ingredient for building an atomic bomb. The president authorized a committee to determine whether nuclear fission was possible, for at that time no ordinary chemical extraction method could separate U-235 from the more common—and nonfissionable—Uranium-238 (U-238).

When émigré German scientists working in Britain deemed such a process feasible, the British government in 1941 sent the United States a report discussing the realities of nuclear fusion. American scientists, anxious that the Germans had a two-year lead, encouraged Roosevelt to initiate a crash program to build an atomic bomb.

The U.S. Office of Scientific Research and Development took the organizational lead on the project, but the War Department assumed control in the autumn of 1942. The latter gave the project its code name, the Manhattan Engineer District, which was shortened to the Manhattan Project. Soon a huge enrichment laboratory and plant was built at Oak Ridge, Tennessee. Harold C. Urey and his colleagues at Columbia University devised an extraction system that was based on the principle of gaseous diffusion, and Ernest O. Lawrence at the University of California–Berkeley implemented a magnetic process to separate the two isotopes U-235 and U-238. A gas centrifuge was then used to separate the lighter U-235 from the heavier, nonfissionable U-238. Following this, only one final test remained: to "split the atom."

More than $2 billion was spent and some of the most renowned minds of the time worked on the Manhattan Project. One of those scientists was J. Robert Oppenheimer, who oversaw the project from conception to completion. Brigadier General Leslie R. Groves, who had served as deputy chief of the Army Corps of Engineers Construction Division and who oversaw the building of the Pentagon, would serve as the military authority over the project. His military colleagues considered him an "able, aggressive, and industrious officer who repeatedly demonstrated superior engineering, administrative, and organizational abilities."

With the bomb becoming a reality, it was now viewed as more than a must-have defensive weapon against the Germans and Japanese. Now it was perceived as the offensive

The Boeing B-29 Bock's Car, which dropped the atomic bomb on Nagasaki, can be found at the magnificent Air Force Museum at Wright Patterson Air Force Base, Ohio. (U.S. Air Force) trump card that could not only terminate the war but also be used by the victors in their efforts to police the world after the war.

With the establishment of the Los Alamos facility on 1 April 1943, where the world's first atomic bomb would eventually be constructed, the army's basic structure of organization to administer the program was in place. In the spring of 1944, Chief of Army Air Forces General Henry "Hap" Arnold and Brigadier General Groves agreed on the broad division of responsibilities in preparing to actually deliver the atomic bomb to a target. The USAAF would organize and train the requisite tactical bomb unit and exercise control over delivery of the bomb. The Manhattan Project (i.e., Groves) would receive from the USAAF whatever assistance it needed in ballistic testing of bombs and air transportation of materials and equipment. The USAAF unit subsequently designated to deliver the bombs on Hiroshima and Nagasaki was the 509th Composite Group, formally activated on 17 December 1944. The bomb was successfully tested on 16 July 1945 at Alamogordo, New Mexico, and less than a month later the Japanese surrendered. The atomic bomb ushered in a new postwar atomic reality: It would be used as a military and diplomatic deterrent by the Western powers against Soviet aggression. The means to carry and deliver the atomic message would be the world's strongest force: the United States Air Force.

George M. Watson Jr.

See also

Arnold, Henry H. "Hap"; Hiroshima

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Austria-Hungary

A major power in the early use of air warfare. Aviation roots ran deep in the Austro-Hungarian Empire, which undertook the world's first aerial attack in 1849: two unmanned balloons, laden with explosives, launched and aimed at the Italian arsenal in Venice.

Following this promising beginning, however, progress slowed, and by the time World War I erupted the Dual Monarchy could only lay claim to a single aircraft builder, Lohner. Lacking the industrial capacity of Germany, Austro-Hungary's aviation did not develop as rapidly prior to, or during, the war. A good comparison can be seen in the prewar investment of the two powers: Austria-Hungary spent the equivalent of $318,307 on military aviation in 1914, whereas German investment that same year was $14,836,726. Despite the inauspicious start, however, Austro-Hungarian achievements were impressive.

During the war, the aircraft industry expanded to the point that, at the Armistice, another nine companies had joined Lohner in the aircraft field. It should be pointed out, however, that many of these firms, such as the Ostdeutsch Albatros Werke (East German Albatros Work), were branches of German aviation companies set up in the Habsburg Empire to assure that the wartime military needs of Germany's ally were met, as well as to exploit the possibilities of the Austro-Hungarian market. The number of workers engaged in aviation production had grown steadily as well, from 1,400 in 1914 to 12,000 in October 1918. Those 12,000 workers had managed to produce a respectable 4,768 aircraft for the army and another 413 for the navy, as well as 4,900 engines. The design departments were also busy, cranking out some 125 different prototypes, as well as two tethered helicopter designs intended to replace observation balloons.

Many names with bright futures came out of the Austro-Hungarian design offices of World War I, including Ernest Mach, Ferdinand Porsche, and Igo Etrich, among others.

Wartime command of the Austro-Hungarian Luftfahrtruppe (Aviation Troops) fell to the very capable Oberst (Colonel) Emil Uzelac, a post held by generals in the other European air forces. Uzelac was highly regarded by his superiors as well as the troops under his command and was noted for regularly seeking out the advice and opinions of the lower ranks when inspecting aviation fields. Both a pilot and an engineer, as well as being organizationally gifted, Uzelac was able to mold the Luftfahrtruppe into a highly effective fighting force that soldiered on right up to the end of the empire.

Austria-Hungary, like its German ally, was forced to fight on two fronts: Russia to the north and Italy to the south. Its position was complicated even further by the diverse and stratified society that populated the Dual Monarchy, where 14 different languages were spoken. Although the language of command was uniformly understood, its vocabulary was limited to approximately 200 words. This forced the burden of day-to-day management onto local noncommissioned officers (NCOs) who were able to communicate with the troops. Yet despite the heavy reliance placed on its NCO force, the stiffly structured social tradition of the Austro-Hungarian military denied these men promotion to the officer corps. In Germany, a talented and successful NCO pilot might expect a promotion to the commissioned ranks, but this never happened in the Austro-Hungarian military. Of the 49 Luftfahrtruppe pilots who achieved ace status during the war, 19 were NCOs. Only one of those 19, Josef Kiss, whose 19 victories placed him fifth on the aces' list, was promoted to *Leutnant* (second lieutenant), and that honor was achieved only posthumously.

Aircraft and airmen operating in Austria-Hungary had to be rugged to withstand the rigors of the mountainous terrain over which the aerial battles were fought. Oftentimes, a forced landing was deadlier than an opposing airman. Naval operations were equally hazardous, with regular trips in frail-looking Lohner flying boats from the naval air station at Pola across the Adriatic and back to and from that favorite target, Venice.

In the end it all came to nothing. Like its German counterpart, the Luftfahrtruppe did not survive the Armistice. With the collapse of the Habsburg Empire and the end of the war, Austria-Hungary was obliged to dismantle its air force. Under the supervision of the Inter-Allied Control Commission, the remnants of the Austro-Hungarian aviation accomplishment were reduced to cinders.

James Streckfuss

See also
Caproni Aircraft; World War I Aviation

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Automobile Industry, Wartime Mobilization of

The American automobile industry responded slowly to agitation for industrial mobilization before World Wars I and II. When conflict erupted in August 1914, automakers decidedly endorsed President Woodrow Wilson's proclamation of neutrality. Automotive executives opposed schemes to divert raw materials, capital, and labor to defense production. Henry Ford, a strident pacifist, forbade Ford Motor Company from producing for sale to any belligerent.

Attitudes changed after the sinking of the *Lusitania.* Convinced that war was imminent, conservative automakers began clamoring for preparedness. Howard Coffin, vice president of the Hudson Motor Car Company and president of the Society of Automobile Engineers, became the spokesperson for this group, but he was ineffective in mobilizing their efforts.

Once the United States entered the war, patriotism prompted automakers to embrace industrial mobilization. Ford abandoned his neutral stance and pledged his factories to war production without concern for profit. Hudson, Packard, and other manufacturers inventoried their facilities and converted their plants to arms production.

Though committed to all phases of the war effort, automakers were interested chiefly in aviation. Public confidence was so high that in July 1917 Congress appropriated $640 million for army aviation. Coffin convinced Congress to establish the Aircraft Production Board to administer the appropriation and facilitate the design and manufacture of airplanes. Automobile executives dominated the board, and they labored tirelessly to convert their factories to aircraft production. Work began immediately on a standardized airplane engine; within weeks, designs for the Liberty engine were finalized and production under way.

Grandiose plans for American aviation were unrealized; automakers proved unable to produce aircraft in appreciable numbers. Rapid changes in technology and design made aircraft unsuitable for assembly-line manufacturing. Aircraft manufacturers, moreover, resisted the automakers' forays into airplane design and manufacturing. The greatest success of the automobile manufacturers was in the mass-production of the Liberty.

By September 1939, automakers again faced the prospect of converting their factories to defense production. In May 1940, William Knudson, president of General Motors, arrived in Washington as head of production for the National Defense Advisory Committee. In that capacity he worked to persuade automakers that the country must prepare for war and that the auto industry was obligated to participate. Aware of the importance of airpower, Knudsen decided to recruit the automobile industry to produce aircraft for the United States and Britain. Automakers agreed to produce airplane parts for Wright-Martin, Boeing, and other aircraft companies. The Automotive Committee for Air Defense was formed to administer this program and facilitate cooperation between automotive and aircraft manufacturers.

In January 1942, the War Production Board (WPB) terminated civilian auto production, and automobile factories shifted to defense manufacturing. The WPB further facilitated conversion by relaxing New Deal antitrust and regulatory policies. In January, automobile leaders established the Automotive Council of War Production (ACWP) to serve as a clearinghouse of information, equipment, blueprints, and designs to expedite war production. The ACWP assumed the activities of the Automotive Committee for Air Defense, working feverishly to reduce mutual distrust and suspicion between aircraft and automobile manufacturers.

Daniel E. Worthington

When the United States mobilized its industry for World War II, it had not yet recovered from the depression, and companies understood that providing a good cafeteria was an important part of their responsibility. (U.S. Air Force)

See also
World War I Aviation; World War II Aviation

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Aviation and the Arts

Film has long been and remains today a popular medium for the treatment of aviation topics in four major genres: entertainment, recruiting, morale-building, and antiwar protest. Indeed, the history of aviation is closely mirrored in the history of film. The first Academy Award ever given for Best Picture went to the 1927 film *Wings.* With the onset of the Great Depression, films were largely escapist and lighthearted and tended to exclude aviation-related subjects. World War II changed this as film became a powerful source for recruitment and morale-building in the military and on the home front. John Wayne in *Flying Tigers* (1942) and Robert Preston in *Wake Island* (1942) garnered strong support for U.S. involvement in the war. *Memphis Belle* (1943) highlighted the determinism of the first U.S. B-17 crew to finish its mandatory 25 combat missions, as did the fictionalized *Air Force* (1943). The air war called for more than just pilots, and *Bombardiers* (1943) proved hugely successful as a recruiting tool.

The Cold War spawned a new generation of films dependent on aviation, not all of which portrayed airpower in a positive light. *Twelve O'Clock High* (1949) showed the personal strain of combat and leadership in a B-17 wing. Jimmy Stewart, a distinguished pilot, starred in *Strategic Air Command* (1955), which called on reservists once again to don a uniform. That same year, *Bridges at Toko-Ri,* adapted from James Michener's novel, served as a powerful antiwar statement, whereas the peril of Soviet espionage was the central theme in *Jet Pilot* (1957). Films during the 1960s grappled with the price of nuclear holocaust in the taut drama *Failsafe* (1964), the farce *Dr. Strangelove* (1964), and the final film in the Strategic Air Command trilogy, *A Gathering of Eagles* (1963). Robert Duvall's masterful portrayal in *The Great Santini* (1980) addressed issues such as the peacetime military, racism, and coming of age, topics previously thought beyond the bounds of traditional aviation cinema. Few films had the popular impact of *Top Gun* (1986), which became the ultimate naval aviation recruiting tool.

As with film, aviation literature has grown with the evolution of aerospace. Charles Lindbergh's *We* (1927) inspired American boys with the urge to fly, providing a ready source of pilots for World War II. Other memoirs such as Robert L. Scott's *God Is My Co-pilot* (1943) and Ted Lawson's *Thirty Seconds Over Tokyo* (1943) added to this patriotic fervor.

General Curtis E. LeMay was not a man given to small talk, but his admiration for a great combat pilot, Jimmy Stewart, was enhanced by Stewart's excellent performance in the film Strategic Air Command. *(U.S. Air Force)*

Throughout the Cold War, aviation literature touted the strengths (or weaknesses) of strategic airpower, then the cornerstone of U.S. national security policy. Tom Wolfe's *The Right Stuff* (1979) offered a captivating view of the early years of the U.S. space race. Through the turn of the century, aviation literature has focused largely on descriptive or technical studies, often based on newly declassified material such as Chris Pocock's *The U-2 Spyplane* (2000) or former Soviet sources like Piotr Butowski and Jay Miller's *OKB MiG: A History of the Design Bureau and Its Aircraft* (1991). Life stories have proven a ready source for aviation literature, with Amelia Earhart's unfinished *Last Flight* (1937), Antoine de Saint-Exupery's *Airman's Odyssey* (1939), Ernest K. Gann's *Fate Is the Hunter* (1961), and Jack Broughton's *Thud Ridge* (1969) among the most significant. Fiction continues to be a popular source for aviation literature, with Craig Thomas's *Firefox* (1977) and Dale Brown's *Flight of the Old Dog* (1987) reaching "superthriller" status in mass-market sales.

Early aviation art tended toward the dramatic, forsaking detail for emotion. Security concerns also blurred the precision in art, especially during World War II and the Cold War. Painters such as Robert Taylor, Keith Ferris, and Mike Machat were crucial in reversing this trend. Taylor, for example, not only painted highly detailed aircraft in authentic markings but also placed them in historical situations. His *Most Memorable Day* depicts Luftwaffe ace General Adolf Galland during a 1941 mission and is countersigned by the artist, Galland, and other Luftwaffe pilots.

Much, if not all, of the work of Taylor and others is bound in multiple-edition color volumes prized by collectors. Ferris showed that life imitates art, as military camouflage schemes derive from artist conceptions, most notably the false canopy. Photography earned its place in aviation art as flight crews and combat camera crews photographed their many missions in both peacetime and war. Strategic Air Command crewmember Clifford Goodie's *Strategic Air Command: A Portrait* (1965) is a definitive black-and-white photo compendium. The work of Hiroshi Seo, Katsuhiko Tokunaga, George Hall, and Jim Benson defined popular aviation photography and appears regularly in books, articles, corporate publications, and official publications around the world.

Robert S. Hopkins

See also

Saint-Exupery, Antoine de

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Aviation Medicine

The science of aviation medicine originated during World War I, when it was recognized that aviators required unique mental and physical attributes and needed special medical care. Early aviators had to endure a myriad of physical challenges never before encountered. Extreme forces of acceleration and deceleration, rapid pressure changes, inadequate oxygen at high altitudes, intense cold, violent winds, blinding glare, prolonged exposure to noise and sickening engine fumes, and dizzying disturbances of the equilibrium—all made specialized screening and care of fliers mandatory. By 1918, all the major powers had medical services dedicated to aviation.

The concept of the flight surgeon was an innovation of senior U.S. medical officers in 1918. After observing the Western Allies' aviation units in action, they became convinced of the need for a specially trained "doctor for the pilot" assigned to a flying unit and dedicated exclusively to treating flying personnel. Although aviation has changed dramatically over the decades, the flight surgeon has survived the test of time. Today, flight surgeons are routinely assigned to U.S. military flying units.

In the years following World War I, advances in flight medicine became even more vital to aviation, as aircraft performance continued to increase at a phenomenal rate. Much greater speeds and forces, higher altitudes, greater extremes in pressure and temperature, and—perhaps more important—the increased complexity and potential destructive capabilities of modern aircraft dictated more stringent medical screening and care of fliers.

These changes also stimulated an increased emphasis on research in the realm of flight physiology. High altitude oxygen systems, pressurized cabins, g-suits, ejection seats and thousands of other life safety developments, can be traced to early research in flight physiology. It is likely that neither combat flying in World War II nor the operation of modern jet aircraft would have been possible without the vital research performed by flight medicine pioneers. The increased comprehension of flight physiology, and the development of aviation life safety equipment that resulted from this research, greatly increased flight safety and paved the way for future space travel.

Steven A. Ruffin

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Avro 504

Early British aircraft that had one of the longest production runs in the history of aviation; brainchild of Alliott Verdon Roe (A. V. Roe). Designed in 1913, it continued in production until 1931. To make it appear the company had many previous designs, A. V. Roe christened it the Type 504 instead of Avro 4, although it was only his fourth design. The plane used an 80-hp Gnome engine with a maximum speed of 82 mph (132 kph). Its wingspan was 36 feet (11 meters) with an overall length of 29.5 feet (9 meters). Flying controls incorporated a joystick and a foot-operated rudder bar. One unique feature on early 504 models was a skid that kept tall grass away from the undercarriage wheels and served as a shock absorber upon landing.

Prior to and during World War I, Allied powers initially chose this aircraft because of its endurance, but its potential as a fighter was quickly recognized. The 504 was the first British airplane to attack a flying Zeppelin, but as a war machine it had limited use. The secret to its longevity as a type rested in its inherent stability, reliability, and ease of control, features that made it an ideal trainer. It was the primary trainer used in British military training schools during World War I. The fact that Prince George, and later King George V, learned to fly in an Avro 504 is evidence of the relative safety of the design.

A. V. Roe's pioneering design capabilities were often disparaged. During his early experiments, because of a superstitious misunderstanding of the science of flight, he was often jailed for endangering the public and himself. And even when his genius was fully displayed with the 504 design, military officials still meddled with his designs, frustrating Roe immeasurably. During the post–World War I period, Roe modified the Avro 504 to include an enclosed cockpit, an all-metal design, and eventually the ability to carry passengers. But by 1928 Roe gave up the fight for control of his designs and sold the company. The Avro 504 remained in production until 1931, having trained an entire generation of military pilots both at home and abroad.

Wendy Coble

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Avro Aircraft

Firm founded by Alliott Verdon Roe, who made his first short hops in an aircraft in 1907. Educated as an engineer and a draftsman, Roe's first successful aircraft was a 9-hp triplane that flew in 1909. He adopted the triplane mode for a number of years and was successful both in flying and selling them.

He founded A. V. Roe and Company in 1910 and built the world's first cabin monoplane and cabin biplane during 1912. In 1913, he created the Avro 504, a classic aircraft that was improved over time and saw service in combat and as a trainer. An Avro 504 was the first British aircraft to be brought down by enemy gunfire, on 22 August 1914. Avro 504s also conducted one of the first strategic bombing operations in history when they attacked the Zeppelin sheds at Friedrichshafen on 21 November 1914. The Avro 504N remained the standard RAF trainer until the early 1930s, and a few Avro 504s were actually in service during World War II.

A. V. Roe sold his company in 1928, leaving to form Saunders-Roe. Avro continued production, principally prototypes and a number of excellent biplane trainers, including the Tutor. It then commenced manufacture of the Avro Anson, a twin-engine aircraft built in many variations; more than 11,000 were produced.

The principal Avro contribution to World War II was the Lancaster, which would lead to the York, Lancastrian, Lincoln, Tudor, and Shackleton aircraft, which were built in relatively small numbers compared to the Lancaster. Research in a jet-powered version of the Tudor provided a basis for a revolutionary aircraft, the Avro Vulcan.

In the general consolidation of British aircraft manufacturers, Avro became a part of Hawker-Siddeley in 1960, a firm that A. V. Roe had helped found in 1935. The name Avro was retained as a part of the Avro Whitworth group until 1963.

Avro Canada was formed by Hawker-Siddeley in 1945 and produced a number of prominent aircraft including, the CF-100 all-weather interceptor and one of the most advanced aircraft of the era, the CF-105 "Arrow." Avro Canada was subsequently acquired by Bombardier.

Walter J. Boyne

See also

Avro Lancaster; Avro Vulcan

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Avro Canada Aircraft (A. V. Roe Canada)

A.V. Roe Canada Limited was established in 1945 by Sir Roy Dobson as a wholly owned subsidiary of the UK-based Hawker-Siddeley Group and was based in Malton, Ontario. In its brief history, from 1945 to 1962, Avro Canada became a world leader in the design of commercial as well as military aircraft.

Following the end of World War II, Avro Canada began work on a passenger jet for Trans Canada Airlines (now Air Canada). In 1946, the Gas Turbine Division (later Orenda Engines) was created to develop jet engines for future Avro aircraft.

The Avro Canada C-102 Jetliner was conceived, designed, and built in Canada. In 1949, the C-102, the world's first commercial passenger jet aircraft, made its debut with four Rolls-Royce Derwent engines, a distinction it shares with the British de Havilland Comet.

Unfortunately, the Canadian government withdrew funding for the program when the Korean War broke out in 1950. In 1956, the C-102 program was officially canceled and the aircraft was broken up. This decision effectively killed Canada's commercial aviation industry.

The Avro CF-100 Canuck was Canada's only operational aircraft designed and built in Canada. It was powered by two Orenda jet engines and was a long-range all-weather interceptor that first flew in January 1950. It entered operational service in 1953 and saw service in the home-defence role (NORAD) as well as overseas as part of Canada's NATO commitment. Approximately 700 of the CF-100 and its variants were built, and it remained in operational service with the Royal Canadian Air Force (RCAF) until 1981. Of these, some 53 were built and sold to Belgium. The CF-100 was NATO's first all-weather fighter, and it performed admirably in the skies over Europe during the Cold War.

Even before the CF-100 was first unveiled, work had begun on its replacement—the truly revolutionary Avro CF-105 Arrow. The CF-105 was a twin-engine delta-wing all-weather supersonic interceptor designed and developed for the RCAF to counter long-range Soviet bombers. No prototypes were ever built; instead, the Arrow was designed to go straight from the drawing board into preproduction. A total of five CF-105 Mk.1s were built. The Arrow was the first aircraft to incorporate fly-by-wire technology that allowed the aircraft to take off and land automatically. It was equipped with the Hughes MX-1179 armament system. By 1956, three years after design work began, some 450 engineers, technicians, and draftsmen were working on the design and development of this sophisticated aircraft and its various systems.

Development problems forced Avro Canada to equip the first five aircraft (Mk.1s) with Pratt and Whitney J75 turbojet engines. Subsequent CF-105s were to be fitted with the more powerful Iroquois engines, capable of producing 26,000 pounds/thrust each. The CF-105 first rolled out of its

The Canadian designed and built Avro CF-100 proved to be a marvelous interceptor, giving excellent service for many years. (Shawn Cafferky)

hangar in Malton on 4 October 1957, the same day the Soviets launched Sputnik, the world's first satellite.

In 1958, the CF-105 began flight-testing, and the aircraft exceeded all expectations. The aircraft reached Mach 1.98 and was capable of carrying four to six Sparrow missiles and up to 12 Falcon missiles in an internal missile bay. It had a range of 2,000 miles. The Canadian government canceled the CF-105 program on 20 February 1959, citing escalating costs, failure to sell the CF-105 and Iroquois engines to allies, and the advent of the missile age. Canada decided instead to purchase the Bomarc missile system and 60 Voodoo F-101B interceptors from the United States.

The cancellation of the CF-105 program spelled the end for Avro Canada, and some 14,000 employees were let go (as were 25,000 others employed by subcontractors across the country). After the cancellation of the CF-105 program, production tooling and blueprints were destroyed. The CF-105s were also destroyed—sold for scrap and then cut to pieces. No record was left of this truly revolutionary aircraft. The little that remains—a single nose cone, for example—rests in the National Aviation Museum in Ottawa.

Shawn Cafferky

See also

Avro Aircraft

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Avro Lancaster

Great Britain's world-famous bomber. The Lancaster was a product of A. V. Roe Ltd., whose design team was led by Roy Chadwick. It had been developed from the earlier Manches-

The finest British heavy bomber of World War II was undoubtedly the Avro Lancaster, a favorite of "Bomber" Harris for his famous Bomber Command. (Big Bird Aviation)

ter, the engines of which had given great cause for concern since its service introduction and led to early withdrawal from the ranks of the RAF.

The redesign included an extension of the wingspan to the allowable maximum of 102 feet plus the installation of four Rolls-Royce Merlins instead of the previous Vultures. The first prototype made its maiden flight, complete with triple fins, on 9 January 1941. After initial flight-testing, some alterations were made to the airframe, the greatest of which were the twin tailfins plus the installation of ventral and dorsal gun turrets.

Service deliveries began to RAF No. 44 Squadron, which undertook its first mission in March 1942. Other units within Bomber Command were reequipped with the Lancaster until 60 squadrons were operating the type. The most famous of these was No. 617 Squadron, which carried out the Dam Busters Raid on 17 May 1943. This unit was also responsible for the deployment of the Tallboy and Grand Slam special bombs.

The Lancaster was also subject to modifications. Some were fairly minor, such as the Lancaster II, with Bristol Hercules engines and a bulged bomb bay; others saw the creation of a completely new type. The Avro York featured a new fuselage, the remainder being pure Lancaster.

After the cessation of hostilities, Bomber Command reduced its strength to a handful of squadrons, although some aircraft were reallocated to Coastal Command as well as units in the Far East and Middle East. Other surplus aircraft were delivered to the air forces of Australia, Canada, Egypt, and France, among others. The final development of the Lancaster resulted in the appearance of the Lincoln bomber, which in turn evolved into the Shackleton antisubmarine patrol aircraft.

Kev Darling

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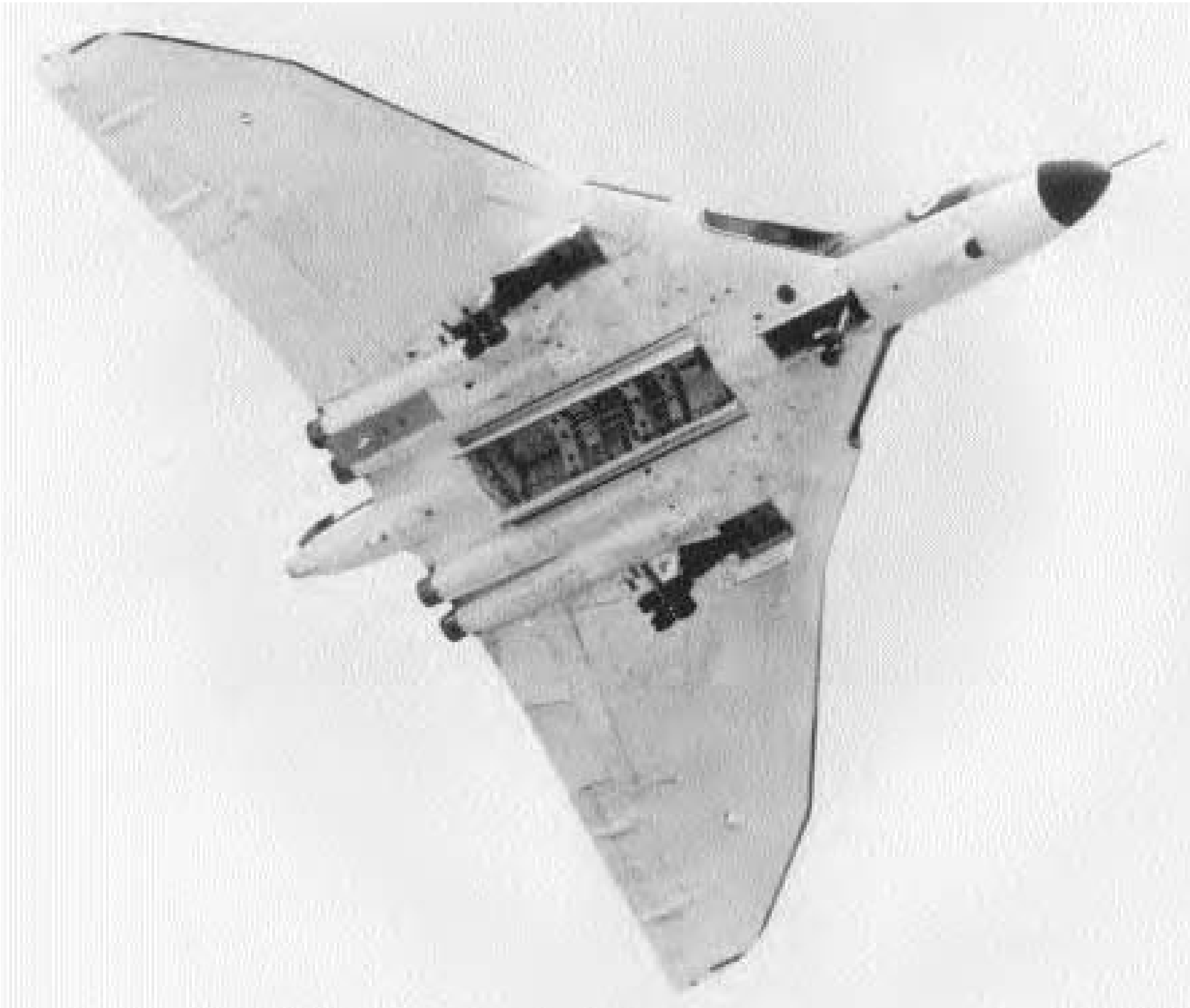
Avro Vulcan

The first delta-wing bomber to enter military service. A product of a 1947 Air Staff requirement, the British Vulcan used the delta planform, which in theory reduced wing loading and drag and increased space for fuel and weapons. However, it took a revision of the leading edge for these benefits to be fully achieved.

The first flight of the prototype, the VX770, took place on 30 August 1952. Service deliveries to the RAF began on 22 February 1957 to No. 230 Operational Conversion Unit at Waddington, the first operational squadron to equip being No. 83. Total production of the first variant, the Vulcan B.1, reached 45 aircraft.

Extension of the Vulcan's capabilities saw the addition of



The last and longest-lived of Great Britain's "V-bomber" force, the Avro Vulcan, was fast and maneuverable. (Kev Darling)

electronic countermeasures equipment in a modified rear fuselage, a cranked and drooped leading edge, and an in-flight refueling system. This new type was redesignated the Vulcan B.1A and was capable of rapid deployment in support of British interests overseas.

Following the success of the first Vulcan variant, the Avro design team developed the concept to produce the far more capable B.2. Changes included a refined wing that featured elevons on the wings' trailing edge in place of the earlier ailerons and elevators. The span of the wing was increased to 111 feet, which allowed extra fuel to be carried and thereby increased the range.

On 1 July 1960, the Vulcan B.2 entered RAF service, where it initially supplemented the earlier Vulcans. The final Vulcan B.2 was delivered in January 1965. Eventually, Vulcan B.2s saw service with nine UK-based squadrons plus two in Cyprus.

The Vulcan's moment of fame came during the Falklands War in 1982, when it flew long-range bombing missions from the Wideawake airfield on Ascension Island to targets surrounding Port Stanley and the Stanley airfield. The last bomber retired in 1985.

Two other versions of the Vulcan were produced by conversion. These were the B.2MRR for strategic reconnaissance and the K.2 tanker, the last variant in service.

Kev Darling

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AWPD/1 and AWPD/42

In July 1941, President Franklin D. Roosevelt asked the secretaries of war and the navy to review their needs to achieve an effective war footing. Henry "Hap" Arnold, commanding the U.S. Army Air Forces, which was reorganized in June 1941, persuaded the Army War Plans Division head to allow the USAAF to prepare its own report, freeing the War Plans Division to concentrate on the needs of land forces. Arnold formed the Air War Plans Division (AWPD) under Colonel Harold L. George. Joined with Colonel George were Major Laurence S. Kuter, Major Haywood S. Hansell Jr., and Lieutenant Colonel Kenneth Walker. They believed that precision daylight bombing was feasible to pinpoint attacks on specific high value targets.

Colonel George and his team formulated a policy that came to be known as AWPD/1; it called for air operations in defense of the Western Hemisphere, relentless air attacks against Germany, and strategic defense in the Pacific theater. The planning team listed 154 targets for its strategic bombing: airframe assembly plants and associated metal production, some 50 electrical generating stations, 47 key points in the transportation network, mostly railroads, and all of the 27 synthetic petroleum plants in Germany.

AWPD/1 declared that the USAAF could launch a campaign in less than a year—half the time the army needed to prepare for war in Europe. It proposed that six months of strategic bombing of enemy targets, together with neutralization of the Luftwaffe, submarine, and naval facilities, would render a land campaign unnecessary. To achieve these objectives, using precision bombing, AWPD/1 calculated the need for 13,000 medium, heavy, and very heavy bombers worldwide. The plan called for a total of 63,500 operational aircraft, including trainers, reconnaissance, light bombers, dive-bombers, cargo planes, and others, not counting replacements. Laurence Kuter calculated the manpower requirements at 2,160,000 men, more than Pershing's entire American Expeditionary force in World War I. Projections of monthly losses of aircraft of 20 percent and personnel losses of 15 percent required that the original force would have to be entirely replaced within the six-month period. Fortunately, though the aircraft and personnel requirements were very accurate, the loss projections were not. The plan was approved in September 1941. AWPD/1 projections formed the basis for production schedules for new aircraft and for training schedules for the USAAF, and the strategic bomber offensive against Germany became accepted as both USAAF and U.S. government policy.

AWPD/1 expectations that German industry could be destroyed by daylight precision bombing because, at least in theory, 90 percent of the bombs dropped on a clear day would explode within one-quarter mile of the target, were born of optimism. In fact, the enemy's electrical power grid proved to be more difficult to bomb accurately than expected; hydroelectric dams required bombs too large to fit inside the bomb bays of the bombers and would have to be released from precariously low altitudes. Petroleum supplies were the Achilles' heel in the enemy's infrastructure, but attacks on oil and the enemy's transportation system would not begin until later in the war.

On 25 August 1942 President Roosevelt called upon General Arnold for a reassessment of future airpower needs. The team that drafted the original AWPD/1 had been reassigned, but Hansell returned from the United Kingdom to direct preparation of a new USAAF plan. The experience of six months of war mandated some changes. Allied shipping losses in the Atlantic redirected bombing priorities to the German U-boat pens. The B-17s and B-24s had proven they could manage round-trip missions to German targets, therefore AWPD/42 recommended that all B-29s to be produced be used against Japan without revealing the number of B-29s to be put it into operation or the date of deployment. As presented, AWPD/42 resembled AWPD/1 in its optimistic assumptions.

The combined Chiefs of Staff denied top priority requested for the USAAF and wanted clarification of Royal Air Force and USAAF bomber roles in Europe. It was decided that the RAF would continue night bombing and the USAAF would do daylight precision bombing. With a few minor modifications, the plan was approved on 9 September 1942 and became the foundation for U.S. strategic airpower. After the war ended, Hansell assessed the effectiveness of AWPD/1 and AWPD/42. He noted that the estimated number of combat groups called for was within 2 percent and the total number of officers and men was within 5.5 percent. He wrote that Japan's ecosystem was shattered by July 1945.

Richard C. DeAngelis

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B

BABYLIFT (1975)

U.S. code name for airlift of orphans during the Vietnam War. Two years after the United States signed a cease-fire agreement with Vietnam, South Vietnam was crumbling under assault from North Vietnamese troops. By mid-April 1975, Saigon was falling and the situation was deteriorating rapidly. Humanitarian groups working with orphans in Vietnam requested that the U.S. government undertake an emergency evacuation. With South Vietnam's reluctant agreement, U.S. President Gerald Ford announced on 3 April 1975 that Operation BABYLIFT would fly some of the estimated 70,000 orphans out of Vietnam. Throughout the month, 30 flights—a combination of private, chartered, and military transport planes—were planned to evacuate babies and children.

Tragically, one of the first official government flights of Operation BABYLIFT was struck by disaster. A USAF C-5A Galaxy cargo plane departed with more than 300 children and accompanying adults. Forty miles out of Saigon and 23,000 feet up in the air, an explosion blew off the rear doors of the aircraft. In a remarkable demonstration of flying skills, the pilots were able to turn the plane back toward Saigon. The damaged plane crash-landed 2 miles from the Tan Son Nhut airport. Sadly, more than half of the children and adults aboard the aircraft died. Many of the 170 survivors were injured. On that same day, a Pan American Airways Boeing 747 chartered by Holt International carried 409 children and 60 escorts, the largest planeload of BABYLIFT.

During the time of Operation BABYLIFT, military and private planes flew out more than 2,000 babies and children to be adopted by families in the United States; approximately 1,300 children were flown to Canada, Europe, and Australia.

Albert Atkins

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Bachem BP-20 (Ba 349) Natter

Conceived as an expendable rocket–powered manned interceptor to be launched from a vertical ramp, the Natter (Adder) was semirecoverable (pilot bails out; engine separates from structure and is parachuted for recovery). This approach by Dipl.-Ing. (Graduate Engineer) Erich Bachem was possibly inspired by the July 1939 proposal from Wernher von Braun to the RLM (the Reich Air Ministry) that did not receive a receptive audience until Bachem's August 1944 proposal. The craft's structure was entirely of wood, to be fabricated in cabinet shops. It was powered by one Walter HWK509A-2 bifuel rocket engine of 3,750 pounds/thrust, and boosted by two or four Schmidding 2,650 pounds/thrust solid-fuel rockets that were separated after takeoff. The Natter had a monocoque fuselage and spar-rib wing construction, both with plywood covering. Armament was initially 24 R4M spin-stabilized rockets, later revised to 48 Rohr-batterie rockets.

Fifty prototypes were contracted for and 34 were built. An enlarged version with more fuel and more wing area was also contracted for as the Ba 349B, and three service-test examples were built. The first flight (towed) of the Ba 349A was behind an He 111 on 14 December 1944. The first manned flight, but without power, was on 14 February 1945. The first powered flight (unmanned) was on 25 February 1945. A manned, powered vertical takeoff was attempted on 1 March 1945 but was not successful for unknown reasons. It is not known if the Ba 349B flew. Development of a further refined Ba 349C continued until the war ended. Construction was sponsored jointly by the SS (*Schutzstaffeln,* or protection squads) and the RLM.

The tiny Bachem had a gross weight of 3,900 pounds, a maximum speed of 620 mph, and a range of approximately 50 miles.

Douglas G. Culy

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Bader, Douglas R. S. (1910–1982)

Battle of Britain fighter pilot, squadron leader, and tactician; developed and championed the controversial "Big Wing" theory of defense.

Born on 10 February 1910 in London, Bader attended the Royal Air Force college at Cranwell. Graduating in 1930, he was posted to his first fighter squadron. He crashed in 1931 while performing low-level aerobatics, subsequently losing both legs. Invalided out of the service in 1933, Bader worked for the Shell Petroleum Company until 1939.

Following the start of World War II, Bader gained readmittance to the RAF. He passed his flying examinations and again became a fighter pilot, flying Hawker Hurricanes in England. In early 1940, he transferred as a flight commander to a Spitfire squadron. In June he was given command of No. 242 Squadron, again flying Hurricanes. This squadron, based at Coltishall in the English Midlands, was part of RAF Fighter Command's No. 12 Group.

Dissatisfied with the standard RAF tactics at the time—that is, tight formations and "line-astern" attacks—Bader experimented with looser formations and simultaneous attacks by all available aircraft. During the height of the Battle of Britain, Bader was similarly frustrated by the more southerly based No. 11 Group's strategy of attacking large Luftwaffe formations with a relatively small number of British fighters, often no more than a squadron.

Bader was convinced that attacking simultaneously with three of more squadrons—the so-called Big Wing—was the answer to inflicting more damage on the attacking bombers. Even though a junior officer, Bader appealed directly to No. 12 Group's commander, Air Vice-Marshall Sir Trafford Leigh-Mallory, for support of his idea. As a result of that meeting, Bader's No. 242 Squadron, along with Nos. 19 and 310, were posted to Duxford to implement the concept.

The controversy over the Big Wing continues to this day due to the trade-off in time needed to assemble and position such a large formation of fighters and the necessity to intercept the German attackers before they could drop their bombs. When it worked, the Big Wing concentrated a mass of force against the Luftwaffe and scored numerous successes. Just as often, however, the Big Wing missed taking part in the raid because the intruding aircraft had struck and departed before the massing defenders could get into position.

On 9 August 1941, Bader was shot down over France. He spent the rest of the war as a German prisoner of war, attempting numerous escapes. At the conclusion of the war, Bader was released from captivity and led the Battle of Britain flypast in the postwar victory parade. He left the RAF in February 1946 with 22.5 confirmed victories, the Distinguished Flying Cross, and the Distinguished Service Order with bar.

Douglas Bader was knighted in 1976. He died of a heart attack on 5 September 1982 in London.

Braxton Eisel

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Baer, Heinz (1913–1957)

One of the dominant personalities of the Luftwaffe fighter force and one of the very few pilots to fly in combat for all of World War II. Heinz "Pritzl" Baer scored his first victory on 25 September 1939, as an *Unteroffizier* (corporal), and his 221st and last on 29 April 1945 while serving as a lieutenant colonel in command of Jagdverband 44 (JV 44; 44th Fighter Unit). Baer was the highest-scoring German jet ace, with 16 victories, and the second-highest day scorer against the Western Allies. In February 1942, he became the seventh member of the Wehrmacht to be awarded the Oak Leaves with Swords to the Knight's Cross of the Iron Cross, but a disagreement with Reichsmarschall Hermann Goering kept him from any higher decorations, and his outspoken refusal to obey orders that he considered reckless brought him a demotion in 1943. However, his combat record prevented his court-martial, and in mid-1944 he was given command of, first, Jagdgeschwader 1 (JG 1; 1st Fighter Wing), and later JG 3, two of the most successful units in the Reichsluftverteidigung *(*Air Defense of Germany). Baer was killed in the crash of a light airplane in 1957.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Baikonur Cosmodrome

Soviet/Russian space launch site. All Soviet and Russian manned space flights to date have been launched from Baikonur. Other noteworthy launches include the Salyut space stations, the components of the Mir space station, the unsuccessful test-launches of the N-1 moon rocket, and the single unmanned flight of the Buran shuttle.

Baikonur Cosmodrome is located near Tyura-Tam in eastern Kazakhstan, approximately 1,200 miles southeast of Moscow. The original town of Baikonur lies 230 miles to the northwest; its name was used (unsuccessfully) to conceal the actual location from Western intelligence. Known successively as Tashkent-90, Zarya (Dawn), Zvezdograd (Startown), and Leninsk, the staff settlement near the cosmodrome officially became Baikonur only in 1995.

Construction began in early 1955, after it became clear that the Soviet Union's existing test range at Kapustin Yar was too small for the missiles and launch vehicles to come. The original Baikonur facility, built to test the R-7 intercontinental ballistic missile, was completed in December 1956. The mission soon expanded to include space launch activities, and Sputnik, the world's first artificial satellite, was launched from Baikonur on 4 October 1957.

With the construction of additional launch sites, the cosmodrome now covers approximately 600 square miles. Today, in addition to manned Soyuz flights, Baikonur launches unmanned Proton, Molnia, Zenit, and Tsiklon boosters carrying a variety of scientific and military payloads.

Mark E. Wise

See also

Gagarin, Yuri; Missiles, Intercontinental Ballistic; Salyut; Soyuz Space Vehicle; Voskhod; Vostok

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Balbo, Italo (1896–1940)

Italian politician and airpower advocate. Born in Quartesana (Ferrara) on 5 June 1896, Italo Balbo served as lieutenant in the mountain troops in World War I. After the Armistice he obtained a degree in political science and joined the fascist movement. A born leader, he made a vital contribution to fascism's seizure of power by securing the support of the Po Valley landowners and directing the March on Rome of 28 October 1922.

Perhaps the most charismatic figure of Fascist Italy, Italo Balbo led great armadas of seaplanes from his country to the United States. (Gregory Alegi)

After a brief period as undersecretary for national economy, Balbo became undersecretary for aeronautics on 6 November 1926. He ran the Ministry for Aeronautics for seven years, succeeding Benito Mussolini as minister in September 1929. Balbo obtained a military pilot's license in June 1927 and in 1934 was declared "qualified on all aircraft in service." In August 1928, Balbo transferred from the fascist militia to the Regia Aeronautica (the Italian air force), his rank being equivalent to three-star general.

During his tenure, Balbo defined the mission and spirit of the Regia Aeronautica, earning recognition as the father of Italian aviation. Balbo's work concentrated on creating a solid organization, but his image is forever linked to the four formation flights of 1928–1933 that culminated in the spectacular Italy–United States–Italy flight made by 24 SIAI Marchetti S.55X flying boats. Shortly after being promoted to Air Marshal by Mussolini in August 1933, Balbo was relieved from his post and appointed governor of Libya, a position that also made him commander in chief of forces in the colony.

An admirer of the United States, Balbo was an outspoken opponent of Mussolini's alliance with Germany, anti-Semitic laws, and the June 1940 declaration of war. Because of this, his death on 28 June 1940 in an SIAI S.79 shot down by Italian antiaircraft fire over Tobruk was rumored to have been orchestrated by Mussolini to eliminate a rival. Modern scholarship has completely disproved the notion.

Gregory Alegi

See also
Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II); SIAI Marchetti

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Baldwin, Stanley (1867–1947)

A Conservative member of Parliament from 1908 until his retirement in 1937. Stanley Baldwin served as British prime minister from 1923 to 1929 and again from 1935 to 1937. He was Britain's leader during the 1926 General Strike and the abdication crisis a decade later. Baldwin is perceived today as a key participant in Britain's reluctance in the 1930s to play any role in the Spanish civil war or to face the growing German menace by rearming. He argued that domestic public opinion would not support such a move. Only toward the end of his leadership did he support a rearmament program, though reflecting little outward concern about the growing European crisis. With Neville Chamberlain, he successfully kept Winston Churchill out of high government office throughout the 1930s.

Christopher H. Sterling

See also
"Ten-Year Rule"; Chamberlain, Neville; Churchill, Winston; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Trenchard, Hugh

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Balikpapan

The location of heavy bomber attacks against Japanese oil installations. Balikpapan, on the island of Borneo in the Netherlands East Indies, was the site of the second largest oil and refinery complex owned by the Japanese. The site produced more than 5 million barrels of oil annually, second only to the Palembang complex on Sumatra. The Allies constructed a strategic air base at Darwin, Australia, in the hopes of using B-29s against the oil facilities, but these aircraft did not become available. However, the Allied advances in New Guinea brought Borneo just into range of the B-24s of the Fifth and Thirteenth Air Forces. The long range to the target required stripping the B-24s of much of their armor and ammunition.

The first raid was launched on September 30, but heavy cloud cover over the target rendered it ineffective. An elite naval fighter unit intercepted and shot down four bombers.

Four squadrons of raiders returned on 3 October and were intercepted by more than 40 fighters, the bombers losing seven of their number. In spite of this opposition, a number of hits were scored on the modern Pandasari refinery.

Such heavy losses could not be continually sustained, but arrangements were made for adding special drop tanks to P-47s and P-38s that could thereby provide a few minutes of fighter cover over the target. Escorted raids attacked Balikpapan three times from 8 October to 10 October. The fighter escort gave the attackers a decisive advantage, and much damage was done. A last attack on 18 October was ineffective because of weather.

Total U.S. losses were 22 bombers and nine fighters; 433 tons of bombs were delivered to the target. The refineries were rebuilt and shortly operating again, but the continuing Allied advance soon interdicted the shipping routes from the East Indies, and the flow of oil to Japan ceased.

Balikpapan provides a good example of the usefulness of modifying aircraft—both bombers and fighters—for specific missions, but it also shows the difficulty of causing sustained damage to industrial targets with small conventional bomb tonnages.

Frank E. Watson

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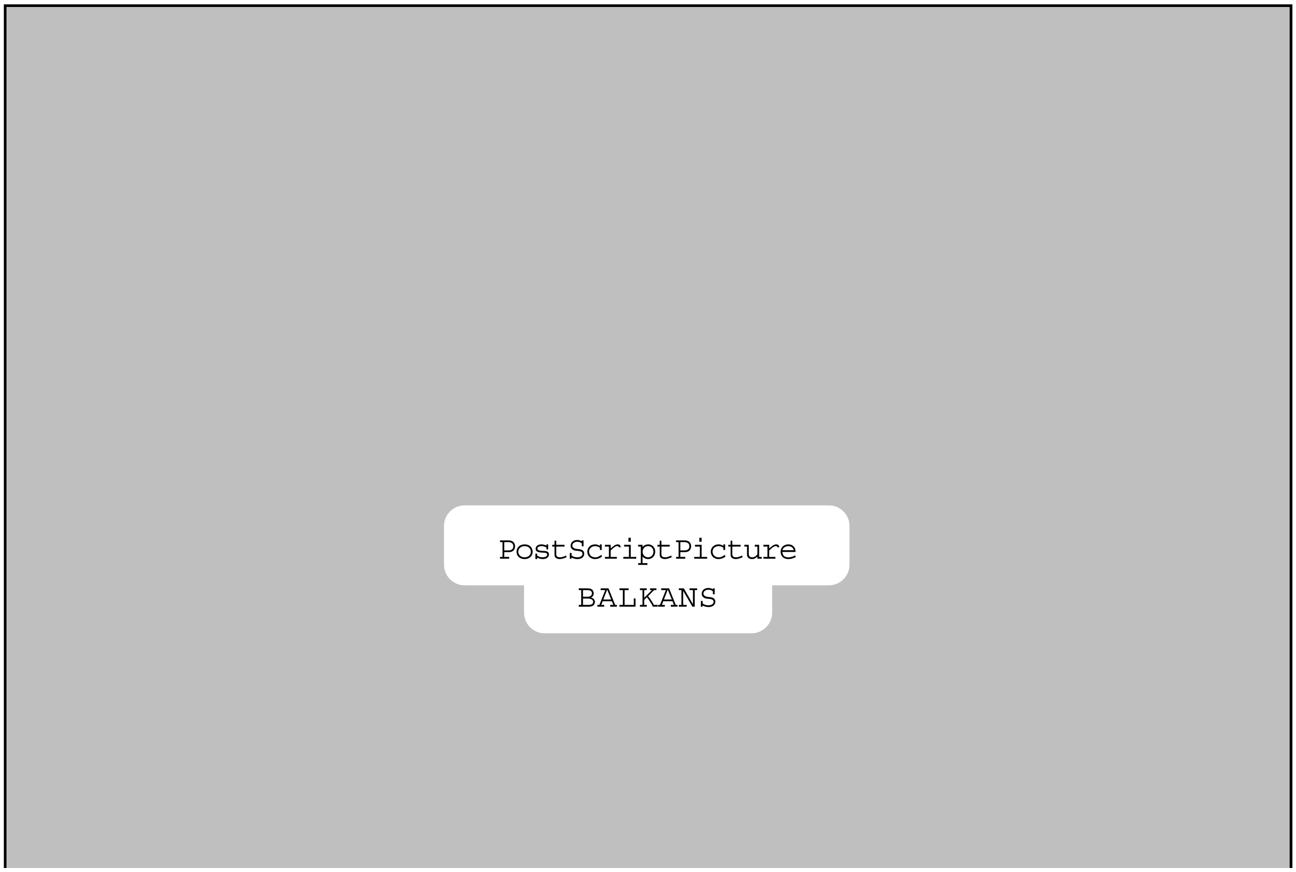
The Balkans, Air Operations in (1941)

German campaigns in the Balkans resulted from Benito Mussolini's botched invasion of Greece in October 1940 and from the overthrow of the Yugoslav government in March 1941. The Luftwaffe buildup began in November 1940, and by March 1941 490 aircraft were based in Romania and Bulgaria. In early April, 600 additional aircraft were rushed to the Balkans. VIII Fliegerkorps executed air operations under the command of General der Flieger Wolfram von Richthofen.



The attack began on 6 April, with an air strike on Belgrade (Operation PUNISHMENT). The target was the city center; industrial and transportation targets were excluded so the Germans could exploit the economy after conquering Yugoslavia. The Luftwaffe attacked in the morning primarily with high explosives and in the afternoon primarily with incendiaries, starting fires that guided the subsequent night attack. The Yugoslav air force was quickly destroyed, and the Germans lost only two fighters. The attack killed some 17,000 people and cut nearly all communications between the Yugoslav high command and the armed forces. The Yugoslav army was paralyzed and easily crushed by the Wehrmacht.

VIII Fliegerkorps then focused on reconnaissance, airfield attacks, interdiction, and close air support. The Luftwaffe supported a three-pronged armored thrust that reached Belgrade on 12 April. The Luftwaffe cleared the path for a diversionary attack on Zagreb and for the pursuit operations that seized Sarajevo on 15 April. Yugoslavia surrendered on 17 April, after negligible German losses.

German air operations in Greece, like those in Yugoslavia, focused primarily on reconnaissance, interdiction, close air support, and airfield attacks. Tactical aircraft played a key role in breaking the Metaxas Line and the positions (Platamon, Pinios Gorge, Thermopylae) the British established to delay the German advance down the peninsula. Airborne forces conducted the most notable German air operations in the campaign. On 26 April, 400 Ju 52s dropped two reinforced parachute battalions on Corinth but failed to prevent large numbers of British troops from escaping the mainland. The British suffered heavy casualties, however, as air attacks sank 26 ships. Airdrops were used to seize some Aegean islands. A major airborne operation (MERKUR) was launched against Crete on 20 May, with German forces consisting of elements of two airborne divisions and two mountain divisions, 700 transports and gliders, and 750 fighters and bombers. Planning and intelligence were poor—German forces were dispersed over a wide area and suffered heavy casualties when they landed among Commonwealth forces. Thus, the Germans nearly lost—the Royal Navy repelled a German seaborne convoy, and Commonwealth troops fought fiercely. Eventually, the Germans captured the Maleme airfield and could fly in mountain troops as reinforcements. Crete fell on 1 June, costing the Germans 5,000 casualties and 350 aircraft, inflicting perhaps 15,000 Commonwealth casualties plus painful naval losses.

Airpower played a decisive role in enabling Germany to conquer Yugoslavia and Greece quickly and with minimal casualties. Even token aerial opposition would have greatly slowed German movements through mountainous Balkan terrain and from inflicting punishing losses on the Royal Navy during operations in Greece and Crete.

James D. Perry

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The Balkans and Early Air Combat (1912–1913)

The First Balkan War (1912–1913) pitted the Balkan League of Bulgaria, Greece, and Serbia against Turkey. It marked a significant point in the history of military aviation, the first international war during which all combatants deployed aircraft operationally.

Serbia was the earliest to form an air arm. Reacting to the 1909 Bosnia-Herzegovina crisis with Austria, Serbia purchased two German observation balloons. In 1912, as war with Turkey loomed, Serbia sent six pilot-candidates to France for training and purchased 11 French aircraft. Its aviators completed training just in time, and on 24 December 1912 the Serbia Aviation Command formed at Nis. Serbian aircraft conducted reconnaissance flights from March 1913. Sergeant Mihajlo Petrovic, killed in action over Skadar in March, was the second combat casualty in military aviation history.

Greece established an air service in late 1911, sending six officers to France for training and purchasing French equipment. Its Aviation Company formed at Larissa in late September 1912 while the navy established its own air service in mid-November. Greek reconnaissance operations commenced on 21 October 1912 (5 October, according to the Julian calendar then in use in Greece) in Thessalia. On 5 February (24 January) 1913, a Greek naval Farman pusher, flown by army Lieutenant Michael Moutousis with Ensign Aristidis Moraitinis as his observer, flew over Turkish naval units off Nara (Nagara Point) in the Dardanelles and dropped four bombs over the dockyard, inflicting no damage and drawing return rifle fire that also missed. Greek aviation activity continued up to the end of the war on 30 May 1913.

Turkey established a balloon unit in 1911 and sent officers to France for flight training the following year. Turkey reacted to events in its war with Italy by expanding its air arm, purchasing close to two dozen aircraft from France, Germany, and Britain. Turkish aircraft undertook frequent reconnaissance missions throughout the First Balkan War.

Bulgaria's air arm was more extemporized. About 12 aircraft, mainly French, were purchased and manned mostly by foreign pilots. These Bulgarian aircraft also undertook reconnaissance missions and one pilot, Topradzijev, achieved the dubious distinction of becoming the first aviation casualty of the war when his Blériot crashed while returning from an operation in December 1912.

Despite their small scale, aircraft operations during the First Balkan War accurately prefigured early events in World War I and validated the importance of aviation in warfare.

Paul E. Fontenoy

See also
Italo-Turkish War

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Ballistic Missile Early Warning System (BMEWS)

Network of three radars designed to give early warning of ballistic missile attack on North America or Western Europe. Though the U.S. Air Force doubted that a successful defense against incoming ballistic missiles was feasible, warning of such an attack was a priority. As early as 1955 the Air Force had recommended the creation of a system of three radars designed specifically to detect incoming missiles, but it was not until the Soviet ICBM test of August 1957, and its highly publicized successor Sputnik two months later, that a similar recommendation received high priority within the U.S. Department of Defense.

Construction commenced in the summer of 1958, and the first site (at Thule, Greenland) gradually became operational throughout late 1960. The last two sites, at Clear, Alaska, and Fylingdales Moor, England, became operational in June 1961 and September 1963, respectively. Upon detection of a missile launched against the United States (or Western Europe as well, in the case of the British site), warning would be transmitted instantaneously to air defense command posts within the United States and Britain. Though the warning provided would only be approximately 15–20 minutes in the case of a Soviet ICBM launched via a polar route against a target within the continental United States, even this amount of time would allow some bombers of the Strategic Air Command to be scrambled into the air and other air defense procedures to be initiated.

Even before it was deployed, however, there were serious questions about the vulnerability of the BMEWS system to a variety of countermeasures. The three radar sites would presumably be among the very first targets struck in a nuclear war and were also thought to be highly vulnerable to the electromagnetic pulse produced by the high-altitude detonation of a large nuclear warhead. Further, attacks not coming in from the north (such as a missile launched from Cuba) could not be detected by the BMEWS sites. Early warning satellites did provide some redundant warning capability beginning in the early 1960s, and as these satellites grew in sophistication they gradually replaced BMEWS as the primary means of detecting incoming ballistic missiles. The multiple redundancies in U.S. missile warning systems proved invaluable in minimizing the danger from the many false alarms associated with the BMEWS system, such as the famous 1960 incident where the Greenland site reported a Soviet missile attack after detecting what turned out to be the moon rising over the horizon. BMEWS remained in service throughout the Cold War, and in the 1980s and 1990s its three sites were upgraded with phased-array radars.

David Rezelman

See also

Air Defense Command; Antimissile Defense; Cold War; Distant Early Warning; Missiles, Intercontinental Ballistic; North American Air Defense Command; Radar; Satellites; Sputnik; Strategic Air Command; Strategic Defense Initiative

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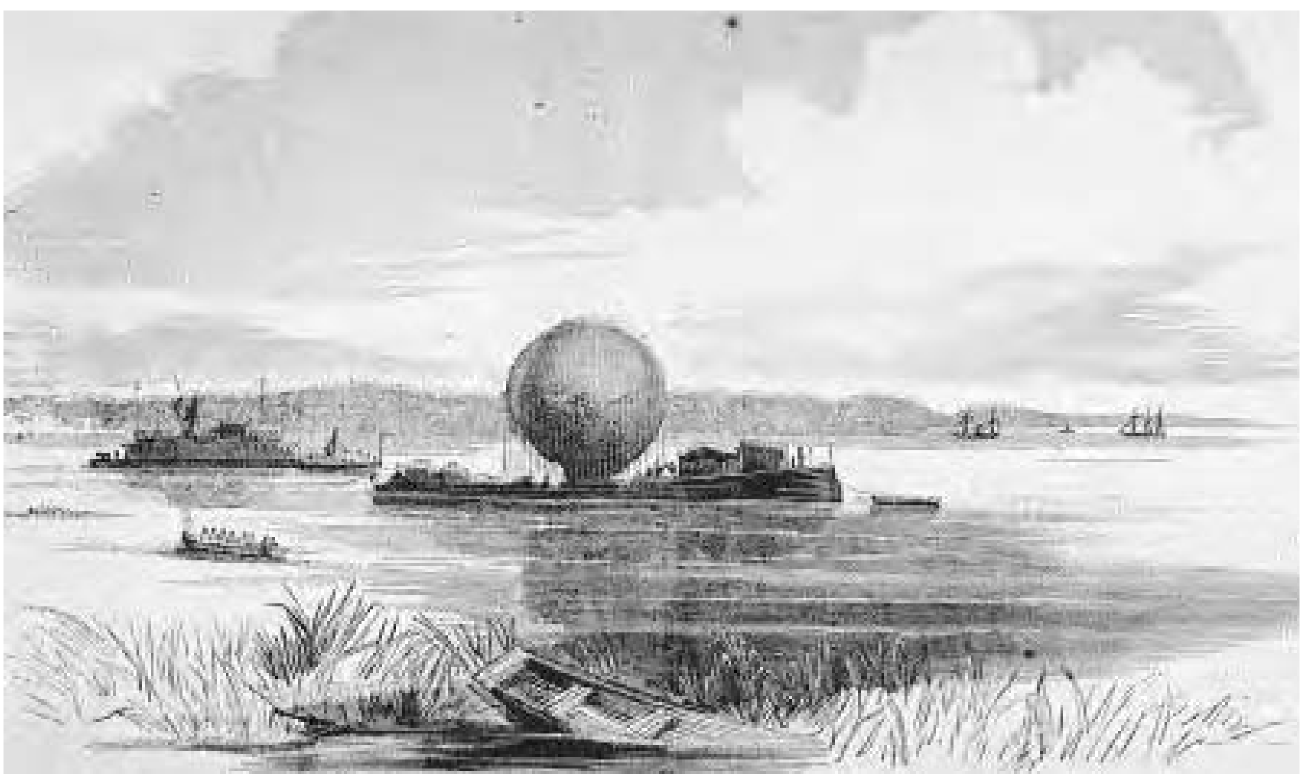
Balloons

The first military use of a man-carrying balloon occurred on 26 June 1794, when Captain Jean-Marie Joseph Coutelle ascended for observation at the Battle of Fleurus. Lighter-than-air craft again saw action in other conflicts, including the American Civil War, when aeronauts used tethered balloons to spy for both armies. But it was during World War I that balloons reached their military zenith.

Reconnaissance was aviation's chief product during World War I, but aviation was not the primary method of getting visual information on the enemy. Climbing to high ground and observing through binoculars was still the favored approach. But as possession of the high ground was often with the enemy, hovering or flying overhead was often



This sketch from the Civil War shows how both sides used balloons to spy on the enemy. (Library of Congress) the only solution. In that chain, the tethered balloon occupied the middle ground between the man on the hill and the man in the airplane.

Balloons and airplanes each had advantages. Balloons could stay aloft for hours and remain in constant telephone contact with one or more artillery batteries, regulating their fire by telling the commander whether his shots were falling long or short or left or right of his target. Balloons were not used exclusively by the artillery, though, because the range or angle of the target in relation to the observer often dictated the closer look possible from the airplane.

The down side was that the balloon was always visible to the enemy and in constant danger of attack. Troops often complained about the presence of a balloon because it drew artillery fire. Enemy pilots considered them formidable targets. Hydrogen-filled, they burned beautifully, but attacking aircraft had to get in close due to the relative ineffectiveness of incendiary ammunition at that time. Because of this, balloons were heavily defended, both by antiaircraft (unusually effective in this case, because, unlike trying to locate aircraft at unknown altitudes, the altitude of balloons—and, therefore, their attackers—was always known) and friendly fighters, which were only a phone call away. Given these factors, pilots who specialized in attacking balloons were highly respected, though considered suicidal.

World War I was unusually suited to the use of observation balloons because of the trenches. By the time fighting in Europe renewed in 1939, technological advances in aviation and the nature of the fighting forced the tethered balloon into a new role: protection. During World War II, balloons proved valuable in forming a barrage around London and other places, holding long steel cables that threatened enemy bombers. Advances in aviation since have eliminated balloons from war and elevated them to the peaceful uses we see them in today.

James Streckfuss

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Bapaume, Battle of (1918)

World War I battle that heralded the rise of air support. By August 1918, the value of aerial operations was no longer debated. At the Battle of Bapaume, a truly coordinated effort with the ground fighting can be seen. The battle opened with rain that interfered to some degree, but RAF No. 73 Squadron was still able to perform ground attack duties, as well as watching out for enemy tanks. As the weather cleared, Handley Pages performed the heavy work of bombing bridges, and the night-flying Sopwith Camels of 151 Squadron flew offensive patrols in search of German ground attack aircraft. On the evening of 24/25 August, they engaged two from Schlachtstaffel 16 (No. 16 Battle Flight) and claimed both as victories. The day of round-the-clock air support had arrived.

James Streckfuss

See also

Royal Flying Corps/Royal Naval Air Service/Royal Air Force; World War I Aviation

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Baracca, Francesco (1888–1918)

Italy's "ace of aces," achieving the rank of major. A prewar pilot as well as a member of the regular army, Baracca was already in military aviation when World War I began. In 1915, he was sent to Paris to train on Nieuports, later returning to the No. 1a Squadriglia (Squadron). By the end of 1917, Baracca had run his score to 30 but then hit a dry spell, not scoring again until the following May. On 15 June, he brought down a double, bringing his victory list to its final number—34. Four days later he was killed under uncertain circumstances. The No. 91a Squadriglia, which he commanded, was renamed in his honor.

In April 1917, he had adopted a black rampant horse as his personal insignia and had it applied to all his subsequent aircraft. The insignia was given to Enzo Ferrari after the war and can be seen today on Ferrari sports cars.

James Streckfuss

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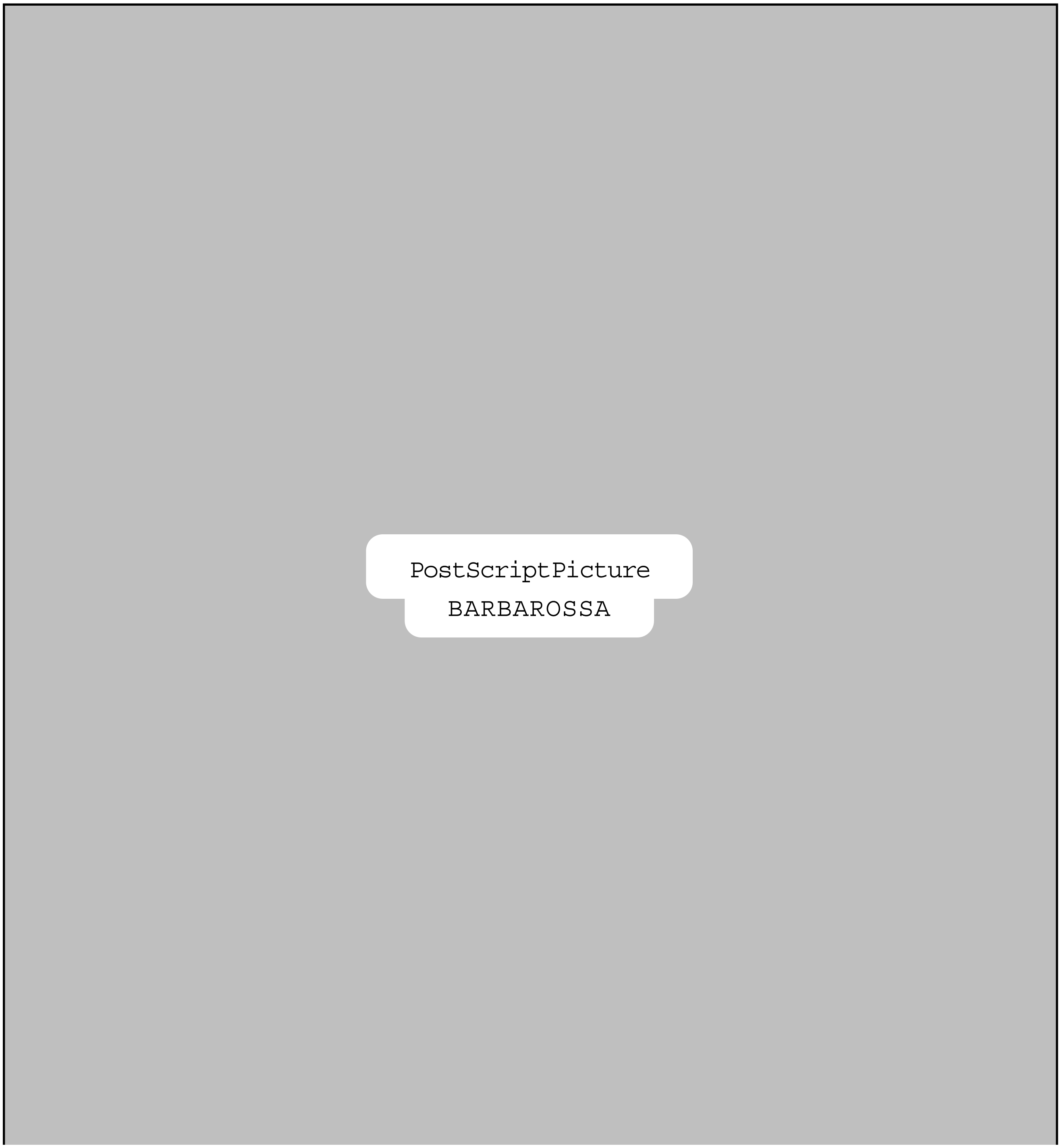
BARBAROSSA

Nazi invasion of the Soviet Union during World War II. Airpower had been important in what became known as Operation BARBAROSSA long before the Germans attacked the Soviet Union on 22 June 1941. German reconnaissance flights, under Colonel Theo Rowehl, had overflown Soviet territory for months, mapping the principal targets.

When the war began, the Luftwaffe was inferior in num-



bers to the Red Air Force, with only 2,770 aircraft deployed for the invasion against some 4,000 aircraft stationed in the West. The equipment and training of the Luftwaffe was far superior, however, and the Red Air Force was handicapped by the loss of many of its best leaders to Stalin's infamous purges. The initial results of the Luftwaffe attack were dazzling, and by 5 October the Red Air Force had lost more than 5,000 aircraft. Many of these were obsolete types, such as the Polikarpov I-16, and they would be replaced by much more advanced aircraft as a result of both Lend-Lease and the miraculous transfer of the Soviet aviation industry eastward from European Russia to the Ural Mountains. The Luftwaffe's failure to develop a long-range bombing force had handicapped it in the Battle of Britain. The same failure would prove to be fatal in BARBAROSSA.

The rapid advance of German forces placed great strains on the Luftwaffe, which suffered losses to Soviet fighters as well as to the intense ground fire encountered in close air-support activity. These strains were increased during the harsh Russian winter, which the Luftwaffe was ill-equipped to endure. The intense cold halted trucks bringing fuel and supplies, made field maintenance a torture, and often prevented German aircraft from flying.

Despite the difficulties, the Luftwaffe managed to maintain air superiority over selected areas of the Eastern Front for the next two years. It was of invaluable assistance to the German army, for German airpower was able to compensate in part for the increasing Soviet superiority in manpower and armor. Field Marshall Wolfram von Richthofen, a cousin of Manfred von Richthofen and an eight-victory ace in World War I, became a master of close air support and the aerial resupply of cut-off forces, but even he was unable to reverse the Luftwaffe's trend toward defeat.

Soviet strength grew steadily, and by Stalingrad's surrender on 31 January 1943, Germany could establish air superiority only locally and on a temporary basis. Both air forces concentrated their efforts on close air support, and in this the Red Air Force became immensely more successful, operating its Ilyushin Il-2 Shturmoviks in great numbers and with great success.

The production battle had also tilted in favor of the Soviet Union. In 1942, Germany was able to produce 15,409 aircraft for use on three fronts, while the Soviet Union produced 25,240 aircraft solely for use against Germany. These were supplemented by reinforcements from Great Britain and the United States. The disparity in strength would grow with each succeeding year.

By mid-1943, the Luftwaffe was so diminished in numbers that it had to be used as a fire brigade, rushing from point to point to stave off the most dangerous Soviet advances. The experience, bravery, and skill of the Luftwaffe pilots enabled some of them to run up unprecedented victory totals, with Erich Hartmann achieving the top score of 352. But such aces were rare, and most of the Luftwaffe pilots were simply ground down in the unending series of sorties that they were called upon to fly.

By the time the Red Army began its final offensive to Berlin in the early months of 1945, it possessed no less than 7,500 fighters, many of which were equal to the best the Germans could offer. The Luftwaffe had less than 400 fighters to oppose them. The Soviet Union had defeated Germany's air force in the air—and on the production line.

Walter J. Boyne

See also

German Air Force (Luftwaffe); Ilyushin Il-2 Shturmovik; Lend-Lease Aircraft; Soviet Air Force; World War II Aviation

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Barker, William George (1894–1930)

Early flier, sadly overshadowed in popular history by other fliers. Major William George Barker was one of the great airmen of World War I, having achieved 50 victories and been awarded the Victoria Cross, the Distinguished Service Order with bar, the Military Cross with two bars, the Croix-de-Guerre, and many other decorations. His wartime achievements were crowned with what many historians believe to be one of the most heroic and one-sided dogfights of the war, in which Barker engaged 15 Fokker D.VII aircraft and, though severely wounded, managed to shoot down four of the enemy aircraft.

Barker was of pioneer stock, having been born in a log cabin in Dauphin, Manitoba, Canada. In December 1914, he joined the 1st Canadian Mounted Rifles, spending his first winter in France as a machine-gunner in the trenches. In March 1916, he became an observer in the Royal Flying Corps and was commissioned as a member of No. 9 Squadron. After entering claims for two victories as a gunner, he entered pilot training in November 1916. (Neither of the two victories were credited to him, but he was decorated with the Military Cross.)

While flying the notorious Royal Aircraft Factory RE 8 (the "Harry Tate") he forced an enemy aircraft down and was awarded a bar to his Military Cross. He was wounded, then transferred to become an instructor pilot, a fact that probably saved his life, for it gave him experience and seasoning that would serve him well when he joined the famous RAF No. 56 squadron in October 1917. He immediately began his scoring and in the next year achieved 50 victories, including nine balloons. Forty-seven of his victories were achieved on the Italian front, most of them, amazingly enough, in one aircraft, his Sopwith Camel B6313. He became a true master of the tricky Camel and was, in addition, an excellent shot.

After his highly successful tour in Italy, he returned to Great Britain and, after checking out in a Sopwith Snipe, obtained permission to take it to France for familiarization. It was there, on 27 October 1918, when he had his epic battle with enemy Fokkers, for which he was awarded the Victoria Cross.

His wounds took him out of World War I combat, and upon his return to Canada he had a mixed career in business and in the service. Sadly, he was killed in a flying accident on 12 March 1930 at Rockcliffe Aerodrome, Ontario.

Walter J. Boyne

See also

Sopwith Aircraft

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Barkhorn, Gerhard (1919–1983)

The second highest-scoring fighter pilot of all time; major general in Germany's post–World War II air force. A Luftwaffe officer cadet from 1937, Barkhorn joined Jagdgeschwader 52 (JG 52; 52d Fighter Wing) during the Battle of Britain and spent most of World War II on the Eastern Front with that famous fighter unit. He flew 120 combat missions before claiming his first air victory, in July 1941, but from May 1942 his score increased rapidly. In January 1944, he became the first German fighter pilot to complete 1,000 combat sorties, on a mission during which he downed his 238th Soviet aircraft. Shortly thereafter he was awarded the Oak Leaves with Swords to the Knight's Cross of the Iron Cross. He left JG 52 in January 1945, after scoring his 301st victory, and briefly commanded JG 6 as a major before joining Adolf Galland's Jagdverband 44 (JV 44—the "Jet Unit of the Aces"; 44th Fighter Unit). A flying accident in April 1945 took him out of the war.

Barkhorn joined the postwar Bundesluftwaffe (the West German Air Force) and rose to the rank of major general before retiring in 1975. In 1983, Barkhorn and his wife were killed in an automobile accident while touring.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Battle of Britain (1940)

See Britain, Battle of

BAT 21

The rescue operation for BAT 21 Bravo, 2–18 April 1972, South Vietnam. This rescue was the largest rescue operation of the conflict in Southeast Asia. BAT 21 was an EB-66 electronic jamming and reconnaissance aircraft. On 2 April, it was hit and destroyed by a North Vietnamese surface-to-air missile as it and another EB-66, BAT 22, escorted three B-52s dispatched to bomb invading North Vietnamese units at the beginning of what has come to be known as the Easter Offensive.

Only one crewmember, Lieutenant Colonel Iceal "Gene" Hambleton, was able to eject from his stricken aircraft. His personal call sign for the rescue operation was BAT 21 Bravo. Immediately, U.S. Army helicopters tried to rescue Lieutenant Colonel Hambleton. But the North Vietnamese guns drove them off and downed one—a UH1 Huey, call sign Blueghost 39. Three of its crewmembers were killed and one was captured.

The next day, Sikorsky Jolly Green Giant helicopters from the 37th Aerospace Rescue and Recovery Squadron made two attempts to pick up BAT 21 Bravo. Both times, they were driven off with heavy damage to their aircraft. Additionally, an OV-10, call sign Nail 38, was hit and downed by an enemy missile. Its pilot, Captain Bill Henderson, was captured. Its navigator, 1st Lieutenant Mark Clark, call sign Nail 38 Bravo, was able to hide and await rescue like Lieutenant Colonel Hambleton.

For two more days, rescue forces fought the weather and enemy forces to try to rescue the two airmen. They could not get in. Instead, hundreds of air strikes were put in to beat down the enemy gunners. But 6 April dawned bright and clear. So, after 42 more air strikes were put in, a rescue force of four HH-53s and six escorting A-1 "Sandy" aircraft launched to make another attempt to recover the two evading Americans. They were assisted by several forward air controllers in O-2s and OV-10s and numerous other support aircraft.

The lead HH-53, Jolly Green 67, was designated to make the rescue attempt. But as it came to a hover over BAT 21 Bravo, it was raked by heavy enemy fire. The escorting A-1s tried to engage the enemy guns, but they could not get them all.

The A-1 pilots could see what the ground fire was doing to the helicopter, and several screamed for the crew to abort the rescue. The crew of Jolly Green 67 complied and tried to maneuver their stricken aircraft to safety. But the enemy fire continued and so damaged the craft that it crashed in a huge fireball a few kilometers south of the survivors. The fire was intense and lasted several days. There were never any indications of survivors.

The A-1 pilots were shocked by the turn of events. The other helicopters were ready to move into the area and make another attempt. But Sandy 01, the leader of the task force, was not willing to risk another aircraft. He terminated the mission; it was just too dangerous.

The next day, another OV-10 supporting the rescue, call sign Covey 282, was shot down in the same area. The pilot, 1st Lieutenant Bruce Walker, call sign Covey 282 Alpha, was on the ground and evading like the two earlier airmen. His crewman, U.S. Marine 1st Lieutenant Larry Potts, was never heard from. With this news, General Creighton Abrams, the overall U.S. commander in Saigon, directed that there would be no more helicopter rescue efforts for the three downed fliers.

Instead, a ground team was formed to attempt to infiltrate through enemy lines and pick them up. It was planned and directed by U.S. Marine Lieutenant Colonel Andy Anderson and led by U.S. Navy SEAL Lieutenant Tom Norris. From 10 through 12 April, the team operated through enemy lines and rescued Clark and Hambleton. They also intended to rescue Walker, but on 18 April he was discovered by Vietcong troops and killed. The rescues were over. Later, Norris would get the Medal of Honor for the mission; his assistant, South Vietnamese commando Nguyen Van Kiet, would receive the U.S. Navy Cross.

This was the largest sustained rescue operation of the Vietnam War. More than 800 air strikes, including B-52s, were expended in direct support. Numerous helicopters, A-1s, and forward air controller aircraft were shot down or damaged. A total of 11 men were killed.

Darrel Whitcomb

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Bay of Pigs Invasion

The 1961 U.S.-backed invasion of Cuba by expatriates. During the 1960 presidential campaign, Democratic candidate John F. Kennedy called Cuban dictator Fidel Castro "a source of maximum danger." He criticized Republican President Dwight D. Eisenhower and Vice President Richard M. Nixon for allowing the "communist satellite" (i.e., Cuba) to spring up on "our very doorstep" and called for "a serious offensive" against the island nation. In turn, Nixon described Kennedy as "dangerously irresponsible" for supporting Cuban refugees trying to overthrow Castro. At that very moment, with presidential approval, covert CIA plans were under way to invade Cuba.

At the time, the CIA enjoyed a special place in government, with a budget reputedly around $1 billion. Later dubbed the "Cuban Invasion Authority," they had built their anticommunist reputation by organizing the 1954 overthrow of the communist-tainted government in Guatemala. In 1960, many CIA leaders privately bragged that their 1,500 Cuban trainees would soon "Guatemalize" Cuba.

The training for the invasion had begun in March 1960, ironically, at sites located in Guatemala. Although the training was modern, the weapons were surplus World War II and Korean War items that included obsolete aircraft.

When Kennedy came to the White House, he found the Cuban-invasion issue on his front doorstep. The CIA assured him of success and of the support of the Cuban people. Kennedy, at first reluctant, felt pressure to go forward, especially since public opinion favored some sort of intervention and Kennedy, during the campaign, had promised to do something about Castro and Cuba. He also feared that the exiles might embarrass him publicly if he failed to act. Even so, on 12 April 1961 Kennedy publicly declared that under no circumstances would the U.S. military become directly involved in Cuban affairs.

Still, he approved the operation, and on 17 April the refugee army landed in force at Bahía de Cochinos (Bay of Pigs) on the southern coast of Cuba. After initial success, things began to unravel. With Castro in direct control of his forces, the Cuban air force soon won control of the skies, and his ground forces surrounded the invaders on the beaches. When Kennedy, under great pressure, refused to send apparently promised U.S. air support, the refugees had little choice but to surrender. With 250,000 Cuban militiamen on alert and almost no popular support, the invasion quickly and completely collapsed.

The entire fiasco was a blow to U.S. prestige. In turn, Castro used the affair to "confirm" his accusations of "Yankee aggression." In fact, the United States had violated its own neutrality policies and laws as well as the spirit, if not the letter, of the United Nations Charter. Worst of all, Kennedy had kept his own UN Ambassador, Adlai Stevenson, in the dark. This caused Stevenson to lie unwittingly when he had declared on 17 April that America had "no complicity in the invasion."

In retrospect, the CIA botched the operation. No such operation could have succeeded without the large-scale internal support of anti-Castro Cubans. These potential supporters were offended by the CIA's inclusion in the exile leadership of henchmen from the regime of hated former dictator Fulgencio Batista. The CIA never alerted the Cuban underground. Instead Castro, ever vigilant to U.S. activities, had rounded up thousands of suspects just prior to the invasion.

The CIA operated as a virtual law unto itself, often ignoring the State Department and other agencies, particularly with regard to Cuban popular support and the viability of the landing site.

In spite of Republican and foreign criticism, Kennedy shunned the opportunity to publicly search for scapegoats. He assumed "full responsibility" for what some Europeans called "a Hungary in reverse." Privately, he blamed the CIA and Joint Chiefs of Staff for poor intelligence and planning. As one historian later noted, even though there was plenty of blame to go around, no one ever seemed to question the policy of attempting to overthrow a sovereign government. Neither did they seem to realize that such an action would push Castro, already seeking a strong anti-U.S. ally, into the waiting arms of the Soviet Union.

Castro emerged stronger than ever. Concurrently, the Soviet Union mistakenly concluded that Kennedy lacked the iron nerve for brinkmanship. By 1962, this would lead to a buildup of Soviet missiles in Cuba and what became known as the Cuban Missile Crisis.

Other byproducts included a seemingly endless economic blockade of Cuba as well as protracted U.S. refusal to recognize the Castro government. The United States made sure Cuba was ousted from the Organization of American States, supported the U.S. Information Agency's anti-Castro program, continued aid to anti-Castro forces, and sponsored assassination plots against the dictator.

Throughout the aftermath, the 1,200 men languishing in Cuban jails weighed heavily on Kennedy's and the public's conscience. In December 1962, the United States violated its own Cuban embargo laws, designed to topple Castro, and opted to allow "private" negotiations and funding to pay Castro $53 million in badly needed food and medical supplies to effect the release of the refugees. Kennedy was roundly criticized for caving in to Castro's demands. Arizona Senator and 1964 Republican presidential candidate Barry Goldwater declared that Kennedy had succumbed to international "blackmail."

William Head

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Beaverbrook, Lord (1879–1964)

William Maxwell Aitken earned a fortune as a Canadian stockbroker, moving to Britain before World War I. He entered Parliament in 1910. He was in charge of British propaganda efforts from 1916 to 1918 and was granted the title of Lord Beaverbrook in 1918. Between the wars he became an important British newspaper publisher of the leading *Daily Express* and (in 1929) the *Evening Standard,* both of which published articles by Winston Churchill. During World War II, Churchill, a close friend, appointed Beaverbrook minister for aircraft production (1940–1941), minister of supply (1941–1942), minister of war production (1942), and Lord Privy Seal (1943–1945). Beaverbrook played a central role in focusing Britain's successful production of thousands of fighters and bombers for the Royal Air Force.

Christopher H. Sterling

See also

Churchill, Winston

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Béchereau, Louis (1880–1970)

Born in 1880 at Plou, France; worked first with the Ader team on cars. In 1909, Deperdussin asked Béchereau to built a canard monoplane, starting a fruitful association. He conceived the first Deperdussin "Monocoque" in 1910. Its racing development won the Gordon Bennett Trophy at Chicago in 1912. The following year, a very-short-span version powered by a 160-hp Gnôme engine, won the trophy, exceeding 203 kph.

After Deperdussin's bankruptcy, the factory was bought by Blériot and retained the acronym SPAD. Béchereau worked on the SPAD VII, a high-performance biplane powered by a Hispano-Suiza 180-hp engine. Reaching squadrons in 1916, the SPAD VII and the later SPAD XIII were the Western allies' most successful fighters, possessing speed, agility, and structural integrity; 7,500 were built.

In 1919 Béchereau joined Bernard, then Salmson, and associated with Kellner in 1932, but his creative work was over. After World War II he worked for Morane-Saulnier before retiring. He died in 1970.

Stephane Nicolaou

Beech Aircraft

The Beech Aircraft Company was founded in 1932 by aviation pioneer Walter H. Beech. Beech began his aircraft manufacturing career in 1924, when he joined forces with fellow

The Beech C-45 served as a utility plane for many years; it was pleasant to fly but tricky to land. (Walter J. Boyne)

aviation pioneers Clyde Cessna and Lloyd Stearman to found the Travel Air Manufacturing Company. The company flourished and by 1929 had become the world's largest producer of commercial aircraft. When the 1929 stock market crash sent aircraft sales into a tailspin, Travel Air merged with the larger Curtiss-Wright Corporation, where Walter Beech accepted an executive position.

In 1932, Walter Beech left Curtiss-Wright to form the Beech Aircraft Company. The first design to emerge from his Wichita factory was the Model 17R Staggerwing. This fast and luxurious single-engine biplane performed better than most military aircraft of the era and gained lasting fame by winning the 1936 Bendix race.

In 1937, the company—now incorporated—introduced its second design, the Beech Model 18 twin-engine monoplane. The versatile Twin Beech proved particularly successful as a military trainer and transport. During World War II, 90 percent of U.S. bombardiers and navigators trained in the Twin Beech.

During the war, Beech produced more than 7,400 military aircraft of various types, plus thousands more subcontracted from other companies. Accordingly, the company was awarded five Army-Navy E awards for production efficiency, an accomplishment only one out of 20 war contracting firms achieved.

After the war, Beech quickly transitioned to the manufacture of moderately priced high-performance commercial aircraft. The company soon replaced the aging Staggerwing with the lighter and more affordable Beech Model 35 Bonanza. This outstanding aircraft was destined to enjoy an unprecedented 35-year production run, and its design served as the basis for the Beechcraft T-34 Mentor, which replaced the T-6 Texan in 1953–1954 as the standard U.S. Air Force and Navy basic trainer.

When Walter Beech died in 1950, the company continued to thrive under the able leadership of his widow and business partner, Olive Beech. It expanded and diversified, subcontracting with major aerospace manufacturers, in addition to continuing to produce successful aircraft. Beech Aircraft Corporation merged with the Raytheon Company in 1980 and has continued to hold its place as a leader in business aviation. Both Walter and Olive Beech are inductees of the National Aviation Hall of Fame.

Steven A. Ruffin

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Bell AH-1 Cobra

During the Vietnam War, the Bell UH-1 Iroquois helicopter proved too slow to escort the new Boeing-Vertol CH-47 Chinooks that were being used to ferry troops into combat. Bell Helicopter won the competition for an interim, fast, armed escort helicopter while the Army was developing the AH-56A Cheyenne gunship, which was ultimately canceled in 1972. The AH-1 Cobra (Bell Model 209) used the transmission, rotor system, and engine from the UH-1C and a two-man crew in a streamlined fuselage that was only 38 inches wide—a much smaller target than the 100-inch-wide UH-1.

The Cobra quickly proved its worth in Vietnam and was ordered by the U.S. Marine Corps and a number of foreign governments in both single- and twin-engine derivatives. Standard armament includes a nose-mounted 7.62mm minigun or 20mm chain gun, plus a variety of missiles, rockets, or other weapons under its stub wings. The Marine Corps version is even capable of carrying AIM-9 Sidewinder air-to-air missiles.

The U.S. Army began to retire the last of the AH-1s in 2000 in favor of additional Boeing AH-64 Apaches. But the U.S. Marine Corps has elected to put its AH-1s through an extensive remanufacturing program to keep them viable until the year 2025 or later. Many other countries are also considering upgrades to their AH-1s, and in fact the helicopter is still in limited production.

Dennis R. Jenkins

See also

Bell UH-1 Iroquois; Boeing AH-64 Apache

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Bell Aircraft

U.S. aircraft and helicopter manufacturer. Innovation characterized Bell designs from its 1935 beginnings. Unorthodox thinking produced the World War II P-39 Airacobra and P-63 Kingcobra that found limited advocacy in the U.S. Army Air Forces, as well as the revolutionary X-1, the first aircraft to exceed the speed of sound.

Founder Lawrence D. Bell gained experience working for Martin and Consolidated in the 1920s and 1930s. When Reuben Fleet decided to relocate Consolidated Aircraft Corporation from Buffalo, New York, to San Diego, California, in 1935, Larry Bell chose to remain behind and create his own aircraft company, initially using the same buildings Consolidated had occupied. From the outset, the Bell team showed a willingness to innovate. The company's first aircraft, the Airacuda heavy fighter, used twin pusher engines to enable the front of each nacelle to house a gunner and large-bore weapons to defeat interceptors of bomber formations. Though the Airacuda did not enter full production, it set the tone for the company's free-thinking designs.

The P-39 Airacobra of 1938, and the follow-on P-63 Kingcobra, netted Bell quantity production orders for more than 9,500 and 3,300 units respectively. Tricycle landing gear, a midmounted engine, and 37mm nose armament in these designs manifested Bell's continuing innovation. The company also built America's first jet aircraft, the P-59 Airacomet, which flew in October 1942. The Airacomet was a learning tool for industry and the Army Air Forces. Though not competitive for World War II combat, the P-59 showcased Bell's ability to pioneer aeronautical designs.

Bell constructed the XS-1 (later X-1) rocket research aircraft to meet an AAF-inspired probe into transonic and supersonic flight. On 14 October 1947, Captain Charles E. Yeager became the first human to fly faster than sound, in an X-1. Bell's swept-wing X-2 was the first aircraft to attain Mach 3 on 27 September 1956, although the aircraft crashed during that mission.

While the upstate New York operations of Bell Aircraft were diminishing after wartime fighter production subsided, helicopters gave impetus to Bell after World War II. The successful Bell Model 47 helicopter was built in the northern United States until Bell helicopter production moved to Fort Worth, Texas, in 1951. Bell ended fixed-wing aircraft programs in 1956, the same year Lawrence Bell died following a heart attack.

In 1960, Textron bought Bell's helicopter enterprises. The expanding helicopter line included the UH-1 for the U.S. Army, the commercial JetRanger, and the AH-1 Cobra gunship. Textron's Bell Aerospace Corporation continued non-helicopter activities in Buffalo, including reaction controls for the X-15 and delivery of NASA Lunar Landing Research Vehicles. Bell Helicopter Textron established a plant in Montreal, Canada, in 1985, adding to capacity already established in Fort Worth and Amarillo, Texas.

Frederick A. Johnsen

See also

Bell P-39 Airacobra and P-63 Kingcobra; Bell UH-1 Iroquois; Bell X-1

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Bell OH-13 Sioux

The Bell Model 47 (U.S. military designation H-13 Sioux) was awarded Helicopter Type Certificate No. 1 on 8 May 1946 and became one of the most popular light utility helicopters ever built. The Model 47 was produced continuously in several countries for more than 30 years, and military versions have been used by at least 40 different countries. The U.S. Army Air Forces procured its first YR-13 (later redesignated H-13) in December 1946.

The Sioux was powered by a single Lycoming piston engine driving a two-blade main rotor and a two-blade tail-rotor. Later models of the H-13 had a top speed of 106 mph and a cruising speed of 80 mph. The H-13 was used for observation, reconnaissance, training, and medical evacuation. In the first extensive application of a helicopter in the medevac role, a cocoonlike stretcher pod could be mounted on each landing skid, a sight made familiar by the television show *M*A*S*H.* The OH-13 earned the nickname "Angel of Mercy" for evacuating some 18,000 United Nations casualties during the war. The OH-13 also saw service during the early days of the Vietnam War before the fielding of the OH-6A Cayuse in early 1968.

Dennis R. Jenkins

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Bell P-39 Airacobra and P-63 Kingcobra

Design of the Bell XP-39, a U.S. fighter, was initiated in June 1936, and its development contract was dated 7 October 1937. The Bell Airacobra was conceived as the smallest fighter aircraft (length: 28'8"; span: 35'10"; wing area 200 sq.ft.) that could be built around the 1,150-shp Allison V-1710 engine with a single-stage supercharger, a turbocharger under the engine, with two .30-caliber plus two .50-caliber machine guns and a 37mm cannon in the nose. Two guns were moved to the wings in the P-39C version.

Two unusual features were the engine location behind the pilot, both being over the wing, and tricycle landing gear. It was of riveted aluminum construction but featured two longitudinal fuselage center-section spars and three wing spars, making a very rigid structure. Automotive fabrication techniques were used to facilitate mass production more so than for most other airplanes of World War II. The prototype first flew on 6 April 1939, demonstrating nearly 390 mph at a gross weight of 5,550 pounds, less armor and armament, at 20,000-feet altitude within five minutes from takeoff. Thirteen YP-39 service-test aircraft were produced, without the turbocharger, and delivered from September through December 1940. The production version (P-39C) weighed 7,075 pounds fueled (100 gallons) and armed, in spite of the turbocharger being removed, because of the addition of cockpit armor plate and four machine guns in the wings. The wingspan (34'0") and overall length (30'2"; area being 213 sq.ft.) were also increased. Initial operational capability was February 1941. Weight increased to 7,650 pounds for the definitive P-39D version (compared with 9,000 pounds for the P-51A), which was first delivered in April 1941. Maximum speed of the P-39C was 375 mph at 15,000 feet, that for the P-39D was 360 mph.

The P-39 design, like the P-38 Lightning's, was based on a turbocharged engine. Turbocharger production problems, as well as a greater need for the turbos for bombers and the P-38, led to the U.S. Army decision to remove the turbocharger, which relegated the P-39 to low-altitude missions. Its small amount of fuel tankage forestalled use in escort missions. Attempts to use it at higher altitudes caused it to be wrongly condemned as a bad-performing aircraft. Objective evaluations ranked the P-39 slightly above the P-40 (which itself has been wrongly maligned for the same reason as the P-39) as an all-around fighter aircraft. The Army ordered an initial batch of 80 P-39s, but the first major production contract was for France; its capitulation led to Britain's receiving the aircraft, which they did not appreciate. The P-39 was eventually assigned to 24 U.S. Army fighter and reconnaissance groups. Five thousand P-39s were enthusiastically accepted by Russia and were applied to low-level interception and ground attack missions. A grand total of approximately 10,000 P-39s were built, with little change from the YP-39 configuration. Laminar-flow wings and a two-stage supercharged V-1710 were experimentally fitted to the P-39, but the successor P-63 Kingcobra was designed to accept these improvements while maintaining the central engine installation and other features of the P-39.

The P-63, despite its similarity to the P-39, was an all-new design to take advantage of the longer Allison two-stage supercharged engine and of new aerodynamic lessons learned from the evaluation of P-39 performance problems. Length was 32'8", wing span was 38'4", and wing area was 248 sq.ft.; maximum weight was 8,350 pounds. The new laminar-flow wing and the addition of a supercharger stage, even without more fuel-tank volume, gave the P-63 much greater range and altitude performance. The longer supercharger placed the engine and cockpit farther forward, the cockpit being in front of the wing. The P-63 development contract was dated 27 June 1941; it first flew on 7 December 1942, and the first production units were delivered in October 1943. More than 3,300 P-63s were built, with more than 2,400 going to Russia.

There will always be a PR man, and the Bell Aircraft Company made good use of one in this photo of their products. From the top, the XP-77, P-39, P-63, and P-59. (U.S. Air Force)

The P-63 was used in the United States for operational training and as a gunnery target, a highly armored version produced for this purpose. The armed version carried the same 37mm cannon and two .50-caliber guns in the nose, in addition to one .50-caliber gun mounted in a pod under each wing. It could also carry three 500-pound bombs or three auxiliary fuel tanks under the fuselage and wings. The Russians used the P-63 as they did the P-39. The French received about 200 P-63s, and they and the Russians flew their P-63s in action into the early 1950s.

Douglas G. Culy

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Bell P-59A Airacomet

On 15 May 1941, the British Gloster E28/39 made its first flight. General Henry H. "Hap" Arnold had seen the aircraft during a visit to Britain the previous month, and when he returned home he asked General Electric to manufacture copies of the Whittle engine under the I-A designation. Because of its close proximity to the General Electric plant, Bell Aircraft was ordered to build an airframe to accommodate two of the new jet engines. These were designated XP-59A as an attempt to disguise them as a version of the now-cancelled XP-59 (no "A") pusher-propeller fighter. The first XP-59A was secretly shipped by train from Buffalo to the West Coast.

The official first flight of the XP-59A was on 2 October 1942 at Muroc Army Air Field in California (now Edwards Air Force Base). America's first jet fighter was a single-seat midwing monoplane powered by two I-A engines of 1,400 pounds/thrust each. A top speed of 404 mph at 25,000 feet was demonstrated, disappointing given that later P-47s and P-51s could easily best it by 20–30 mph. Nevertheless, 13 service-test and 100 production models were ordered, with the third going to Britain in exchange for a Gloster Meteor prototype, and two YP-59As going to the U.S. Navy for evaluation. On 30 October 1943, the production order was cut in half—eventually 20 P-59As were delivered with J31-GE-3 engines, and 30 P-59Bs used slightly more powerful J31-GE-5 engines and had an extra 66 gallons of fuel. All were delivered by the end of May 1945.

Surprisingly, given the pioneering nature of its power plant, none of the service-test models were lost. The P-59 was not fast enough to be suitable as a weapon, but it proved useful in training pilots destined for the Lockheed P-80 "Shooting Star." The shortcomings of the P-59 became even more obvious after the Air Force had a chance to examine the German Me 262 jet fighter toward the end of the war in Europe.

Dennis R. Jenkins

See also
Gloster Meteor; Messerschmitt Me 262

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Bell Tilt-Rotors

The Bell V-22 Osprey tilt-rotor is just beginning to enter military service. It is the first tilt-rotor to see operational service. Bell is already at work on a civilian version (Bell Boeing Model 609) and has recently shown conceptual designs of a much larger four-rotor version (called the V-44 by the industry press) capable of replacing the Lockheed C-130 Hercules.

But the tilt-rotor is not new. Henry Berliner built a tilt-rotor biplane during the 1920s and actually demonstrated forward speeds over 40 mph. George Lehberger patented a single-shaft tilt-rotor "flying machine" in September 1930, and the Focke-Achgelis FA 269 was a pusher tilt-rotor designed in 1942. The Platt LePage firm proposed a large tilt-rotor passenger aircraft during the late 1940s, and although the aircraft was never built, Haviland Platt received a patent on it in 1955.

The Transcendental Aircraft Corporation of New Castle, Delaware, went one better—actually building a small Model 1-G single-seat experimental aircraft. Unfortunately, after more than 100 successful flights that had almost demonstrated the full range of motion required, the aircraft crashed. A subsequent Model 2 version was not extensively tested due to lack of funds.

A common voice through many early concepts was that of Robert L. Lichten. He had worked for Platt and Transcendental before heading for Bell Aircraft. There he was given the chance to develop the Bell Model 200 in response to an October 1953 military order for two full-scale "tilting-thrust-vector convertiplanes." The first of the XV-3 tilt-rotors made its maiden flight on 11 August 1955, and the XV-3s proved to be valuable research tools for the next 13 years.

Bell began flying the definitive XV-15 demonstrator on 3 May 1977, the first turbine-powered tilt-rotor. As with many aircraft types, turbine power revolutionized the concept. The XV-15, although a relatively small aircraft, successfully demonstrated many of the operational aspects of an operational tilt-rotor. The U.S. military, particularly the Marine Corps, was impressed. In June 1986, a Bell-Boeing team was selected for the development of the V-22 Osprey.

Dennis R. Jenkins

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Bell UH-1 Iroquois ("Huey")

In 1955, the Bell Model 204 won a U.S. Army competition for a utility helicopter suitable for front-line casualty evacuation, general utility, and training duties, and it would become the first turbine-powered helicopter to equip U.S. Army units. The aircraft was originally designated HU-1, giving rise to the nickname "Huey-copter" or "Huey," a name that survived the redesignation to UH-1 in 1962. The Huey is the most universal military aircraft of the modern era, serving in all four branches of the American uniformed services and in the armed forces of at least 48 other nations. Eventually, more than 9,000 Hueys (Models 204/205/212) were built—4,890 UH-1H models alone.

The Huey soon found itself in the jungles of Southeast Asia. The first arrived in 1962, and by the end of the war 1,213 UH-1s were lost to hostile action and a further 1,380 to other operational causes. Hueys armed with only two M60D door guns, called "Slicks" because of their uncluttered external appearance, were the backbone of all air-mobile combat operations in Vietnam. Unarmed medevac versions were called "Dust Offs," because of the clouds of dust kicked up when landing. Until the arrival of the AH-1 Cobra, armed UH-1C and UH-1Ms protected the Slicks on their missions.

The U.S. Army began to retire the last of the UH-1s in 2000 in favor of additional Sikorsky UH-60 Black Hawks. But the U.S. Marine Corps has elected to put its UH-1s through an extensive remanufacturing program to keep them viable until the year 2025 or later. Many other countries are also considering upgrades to their UH-1s.

Dennis R. Jenkins

See also

Bell AH-1 Cobra; Sikorsky UH-60 Black Hawk

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Bell X-1

U.S. research aircraft. The Bell X-1 was significant in the history of airpower because it proved there was no sound barrier and also provided design data and technology for future transonic and supersonic aircraft, including the movable horizontal stabilizer that made the later models of the F-86 so superior to MiG-15s in the Korean War. The first of the rocket-powered research aircraft, the X-1 (originally designated the XS-1), was a bullet-shaped airplane that was designed and built by the Bell Aircraft Company for the Army Air Forces and the National Advisory Committee for Aeronautics (NACA), which provided many of the design specifications. The mission of the X-1 was to investigate the transonic speed range (speeds from just below to just above the speed of sound) and, if possible, to break the so-called sound barrier.

The first of the three X-1s was glide-tested at Pinecastle Army Air Field, Florida, in early 1946. The first powered flight of the X-1 was made on 9 December 1946 at Edwards Air Force Base with Chalmers "Slick" Goodlin, a Bell test pilot, at the controls.

On 14 October 1947, with Air Force Captain Charles "Chuck" Yeager as pilot, the aircraft flew faster than the speed of sound for the first time. Yeager ignited the four-chambered XLR-11 rocket engines after a B-29 Superfortress air-launched it from under the bomb bay at 20,000 feet. The 6,000-pound/thrust ethyl alcohol/liquid oxygen–burning rockets, built by Reaction Motors, pushed the aircraft to a speed of 700 mph in level flight.

Yeager was also the pilot when the X-1 reached its maximum speed: 957 mph. Another USAF pilot, Lieutenant Colonel Frank Everest Jr., was credited with taking the X-1 to its maximum altitude of 71,902 feet. The number-three plane was destroyed in a fire before making powered flight.

More advanced versions of the X-1 (the X-1A, X-1B, and X-1E) flew faster. All of them gathered valuable data for future aircraft designs.

J. D. Hunley

See also

Research Aircraft; Yeager, Charles E.

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Beriev Aircraft

Chief designer and manufacturer of maritime aircraft in the Soviet Union. Georgii Mikhailovich Beriev was born in Georgia in 1902 and trained as an engineer in Leningrad after the Bolshevik Revolution. In 1928, he joined a design bureau for naval aircraft. His first task was to make improvements on the Savoia S.62, which had been bought from Italy for license production. In 1932, he launched his own design bureau based at Taganrog, on the Sea of Azov. His first design was the MBR-2 flying boat, which first flew in October 1932. Entering production in 1934, 1,365 were produced by the time Taganrog was overrun by the Germans. Though outdated, with its single pylon-mounted motor, it served as the main Soviet naval reconnaissance and antisubmarine aircraft throughout World War II, helping protect Lend-Lease convoys and even served as a nighttime bomber. It was retired from service in the late 1950s.

Beriev also was responsible for production of the GST, the Soviet-licensed version of the Consolidated PBY "Catalina"; only 27 examples were produced before the factories were overrun in 1942. Other prewar aircraft designed by Beriev were never allocated any priority, never advanced beyond prototype stage, or were produced in minuscule quantities.

From 1950 to 1957, Beriev produced for the Soviet Navy 123 examples of the Be-6, a large, twin-motor flying boat in the general class and format of the Martin Mariner. Beriev next designed the Be-10, a twin-jet swept-wing flying boat intended for antisubmarine patrol. Though it entered naval service, design problems were never completely eliminated, the concept was dated, and production ceased in 1961 after only 27 examples were produced.

Much more successful was the Be-12 amphibian flying boat, known to NATO as "Mail." This antisubmarine aircraft had a gull wing, twin tails, and two turboprop engines and was produced from 1964 to 1973; some of the 132 examples remained in service at the turn of the century. Others have been rebuilt as firefighting water bombers.

Beriev died in 1979, but his bureau continues. It has been involved in the experiments with the Ekranoplane "wing-in-ground-effects" aircraft, as well as the new Be-42/A-40 Mermaid amphibious flying boat currently under development.

George M. Mellinger

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Berlin Air Battles (1940–1945)

The attempts to carry the aerial war to the capital of the Third Reich and draw out the Luftwaffe in its defense. Before August 1940, Berlin remained unscathed by Royal Air Force bombers. In that month, however, RAF Bomber Command launched two attacks in retaliation for the Luftwaffe's bombing of London. Executed by Vickers Wellington, Armstrong Whitworth Whitley, and Handley Page Hampden twin-engine bombers flying at the extremity of their ranges, the raids did very little damage and killed few people. They nonetheless marked the beginning a years-long campaign to take the war to Hitler's center of power. In what became the RAF's largely nighttime "city-busting" campaign, the objective was to sap German morale and cripple their industry by "dehousing" workers. If factories and administrative centers were hit as well, then so much the better. Such tactics rested principally upon early RAF bombers' ineffective defensive armament in daylight and a lack of accurate bombsights. Even the RAF's introduction of the four-engine Short Stirling and Handley Page Halifax bombers in 1941 and the superb Avro Lancaster in early 1942 did not significantly alter this operational doctrine.

Nevertheless, the weight of Bomber Command's assault on Berlin and other cities grew accordingly, and the Eighth Air Force of the U.S. Army Air Forces soon joined the fray. In late 1943, the RAF launched a sustained effort to pulverize the Reich capital. Building on the successful 1,000-bomber raids of 1942, Air Marshal Arthur "Bomber" Harris believed that Berlin's destruction would cost Germany the war. On 18 November, Harris ordered 444 heavy bombers to Berlin. Of that number only nine were lost. Harris, encouraged, kept up the effort. Bomber Command sent in 15 more major attacks by the end of March 1944. From the 9,111 sorties, 492 bombers failed to return. Another 95 crashed at their bases, and 859 others suffered battle damage. These raids did not include yet another 16 smaller harassing attacks during the same period. Altogether more than 1,000 RAF bombers of all types were lost during the efforts against Berlin.

Up to this time, the Eighth Air Force had not participated in the raids on Berlin. It was still recovering from severe losses suffered in the second half of 1943, during the raids on Schweinfurt and Regensburg. Its efforts were also affected by diversions to the newly established Fifteenth Air Force in Italy. The Eighth's effort against Berlin took shape, however, under the Combined Bomber Offensive (CBO) directive of 13 February 1944. The directive specified targeting Berlin whenever possible. Planners reasoned, in part, that the Luftwaffe would fight for the city, as it would fight for no other; and the consequent destruction of the Luftwaffe's planes, pilots, and infrastructure by the Allies' aerial forces remained the CBO's primary objective.

As over targets such as Hamburg in 1943, the RAF bombed at night, the Eighth Air Force during daylight. The dramatic difference in early 1944 was the presence of long-range escorts, principally North American P-51 Mustangs, that were able to accompany the bombers all the way to the target (indeed, beyond it) and back. The replacement of any German pilots killed became increasingly difficult due to the Luftwaffe's simultaneously constricted resources on the ground. That weakening of German airpower, in turn, would make an Allied invasion of northwestern Europe that much more likely to succeed. On 4 March 1944, the Eighth Air Force carried out its first daylight raid on the German capital. Three additional attacks followed before month's end. They comprised some 1,700 sorties by Boeing B-17 Flying Fortresses and Consolidated B-24 Liberators escorted by hordes of fighters. Specific targets included the VKF Erkner ball-bearing facility, the Bosch electrical works at Klein Machow, and the Daimler Benz engine factory at Genshagen.

The Luftwaffe reacted fiercely throughout. For example, 69 of the Eighth Air Force's big bombers fell on 6 March alone, losses as high as over Schweinfurt and Regensburg in 1943. In exchange, 81 German fighter aircraft were shot down on that same day. Still, the Eighth continued its effort throughout the rest of 1944 and into 1945 though the regularity of attacks on Berlin decreased. In addition, Fifteenth AF bombers executed their first large raid on the city on 24 March 1945, a mission exceeding 1,500 miles in total distance. The consequence, as Harris put it, was "the wrecking of Berlin from end to end," though Germany did not lose the war as a result.

Heavy and effective Luftwaffe flak served as Berlin's ground-based defense. As late as the Eighth Air Force's raid of 3 February 1945, these guns clawed fully 25 heavy bombers from the skies. In addition, radar-directed day- and night-fighters rose to defend the city. They included late-model Messerschmitt Bf 109s and Focke-Wulf Fw 190s carrying heavy machine guns, cannons of up to 30mm, and,

The United States responded to a military crisis, the Berlin Blockade, with a magnificent compassionate gesture, the Berlin Airlift. Douglas C-54s were soon bringing in more supplies by air than had previously been brought in by rail, road, and canal. (U.S. Air Force)

occasionally, air-to-air rockets. Also attacking the bombers were radar-equipped twin-engine Bf 110s armed (at night) with the dreaded Schräge Musik (Jazz Music) twin 30mm cannon designed to fire diagonally into the bombers' ventral surfaces. One twin-engine fighter, the follow-on Me 410 Hornisse (Hornet), even mounted a massive 50mm cannon—a true bomber-killer. Most fortunately for Allied airmen over Berlin, the potential of the elegant but deadly Me 262 Schwalbe (Swallow) cannon-armed jet fighter never materialized. Neither did that of the extraordinary Me 163 Komet (Comet) rocket-propelled interceptor.

D. R. Dorondo

See also

Avro Aircraft; German Air Force (Luftwaffe); Germany, and World War II Air Battles; Harris, Arthur T.; Messerschmitt, Willy; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Short Aircraft (Post–World War I); U.S. Army Air Forces

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Berlin Airlift

From June 1948 until September 1949, the early period of the Cold War, Western powers supplied the city of Berlin solely by means of air transport when Soviet forces cut off rail, river barge, and road traffic in a political power play to squeeze Britain, France, and the United States out of Berlin. Using a variety of aircraft, the Berlin Airlift continued until September, despite the fact that ground restrictions were lifted in mid-May 1949, as it took months to build up the city's stocks of vital supplies to a safe level.

When the airlift began on 24 June 1948, the Western powers were woefully outnumbered in troops, equipment, and aircraft by the Soviets occupying East Germany and half of Berlin. The notion of supplying a city of almost 3 million people only by air originated with a Royal Air Force official faced with the city's pre-airlift daily need of 15,000 imported tons of supplies, with 4,000 being the absolute minimum to survive. At the beginning, the U.S. Air Force could supply but 700 tons using the 25 available C-47 aircraft. The British pressed 40 Dakotas, 35 Avro Yorks, 26 Handley Page Hastings, and a few Sunderland flying boats into service on what the Americans soon dubbed Operation VITTLES (Operation LITTLE VITTLES was the dropping of candy by airlift pilots to Berlin children). Some British charter airlines also participated using Avro Tudors, Handley Page Halifaxes, and Consolidated Liberators. By August 1948, U.S. C-54s took the bulk of the airlift, more than 300 of them eventually participating, some loaned by U.S. nonscheduled airlines. Pilots flew up to 70 hours within any 30-day period.

The airlift soon established three air corridors, each 20 miles wide, across the Soviet zone of occupation to reach the Berlin airfields of Tegel, Gatow, and Tempelhof, plus one water base at Havelsee. Pavements were built or extended, often by Berliners working only with hand tools. Very careful flight paths were arranged due to the heavy traffic—with dozens of aircraft movements per hour. The average aircraft turnaround time in Berlin was less than 50 minutes, so intense was the pressure. Indeed, the full airlift scheme reached as far as the U.S. West Coast, whence came some of the supplies and to which some aircraft had to return for maintenance.

All told, the U.S. Air Force brought some 1.4 million tons of coal, nearly 300,000 tons of food, and 65,000 tons of other material into Berlin. This allowed a typical Berliner to receive, under a tight system of rations, 15 ounces each of bread and potatoes, 1.5 ounces of sugar, 1.75 ounces of prepared foods, 1.5 ounces of meat, and about an ounce of fats and a twentieth of an ounce of cheese. For the winter season, however, less than 30 pounds of heating fuel (be it coal or wood) were available per person. To help stretch supplies, some 15,000 children were flown out of Berlin during the airlift. Amazingly, only 22 accidents occurred, with 30 crew deaths. The airlift cost slightly more than $137 million in monetary values of the time. No airlift operation since has carried as much to so many in such a brief period of time.

Christopher H. Sterling

See also

Airlines, Service During Wartime

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Bien Hoa Air Base

Base located 25 kilometers northeast of Saigon in South Vietnam. During the period 1961–1964, Bien Hoa, along with Da Nang and Tan Son Nhut, were the chief operating locations of U.S. Air Force advisers.

On the morning of 1 November 1964, Vietnamese communist troops attacked Bien Hoa. Positioning six 81mm mortars about 400 meters north of the base, the enemy gunners fired 60–80 rounds onto parked aircraft and troop billets. The Vietcong (VC) then withdrew undetected and unmolested, leaving behind damage completely disproportionate to the effort expended. The barrage killed four U.S. military personnel and wounded 30. Of 20 B-57 jet bombers hit, five were destroyed, eight were severely damaged, and seven were slightly damaged. Increasingly thereafter, U.S. air bases in the Republic of Vietnam (RVN) became routine targets for enemy ground attacks as well as standoff attacks.

On 16 May 1965 at Bien Hoa, an accidental explosion aboard a parked B-57 triggered a series of blasts that killed 28 and injured 77 people. The aircraft toll reached 10 B-57s, two A-2Hs, one A-1E, and one F-8U destroyed, plus 30 A-1Hs and one H-43 damaged. Also demolished were 12 pieces of aerospace ground equipment, 10 vehicles, and the JP-4 fuel dump. This one incident was more destructive than any single VC/NVA attack on any air base during the entire Vietnam War. The incident resulted in a U.S. Air Force–directed emergency program for revetment construction.

Bien Hoa Air Base, a major USAF/South Vietnamese air base that harbored all types of aircraft, was a consistent target for VC standoff harassment fire. While attempting to hit parked aircraft hidden under the ever-tightening rows of concrete revetments, VC rocket attacks often reaped secondary rewards by hitting ammo dumps and troop areas.

George M. Watson Jr.

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Bikini Atoll Tests

Pacific Ocean site of early U.S. nuclear tests. At Bikini Atoll, 23 atmospheric nuclear and thermonuclear tests were conducted between 1946 and 1958. Bikini is one of 29 atolls and five islands that compose the Marshall Islands. It comprises a total of 2 square miles consisting of 36 islets on a reef 25 miles long. It was chosen as a test site because of its remoteness from regular air and sea routes. The original inhabitants were moved to other islands after Bikini became part of the Pacific nuclear proving ground of the United States.

The first post–World War II nuclear weapons test was conducted at Bikini in July of 1946. Operation CROSSROADS was designed to determine the effects of these bombs on naval vessels. In preparation, a fleet of more than 90 target ships with a support fleet of more than 150 vessels was assembled in the Bikini lagoon. The 42,000 participants witnessed a series that consisted of an airdropped bomb detonated at a height of 520 feet (ABLE) and an underwater shot conducted at a depth of 90 feet (BAKER). The tests produced mixed results. Only a few ships were sunk by the first bomb. The second detonation produced substantial fallout and contaminated part of the support fleet.

In the spring of 1954, Bikini Atoll became the site of Operation CASTLE. This testing series was the culmination in the development of the hydrogen bomb; between March and May six tests were conducted at Bikini and neighboring Enewetak. The most prominent of those tests was BRAVO. Despite unfavorable weather conditions and faulty pretest yield calculations, the test was executed on 1 March and produced a yield of 15 megatons and created a worldwide fallout scare.

After the blast had created a large crater in the reef, fallout spread and not only threatened the onsite service personal but contaminated Japanese fishermen and Marshall Islanders. The Japanese tuna trawler *Lucky Dragon,* with a crew of 23, was severely contaminated. Marshall Islanders on Rongelap (about 100 miles east of Bikini) were also severely contaminated, and many had to be treated for symptoms of beta and gamma radiation. A worldwide wave of protest followed, with international calls for an end to nuclear testing.

Despite the protests, testing continued. On Bikini, the last series was conducted in 1958. The Pacific phase of Operation HARDTACK consisted 34 nuclear detonations, all but two on Bikini and Enewetak.

Since 1960, the U.S. government and the original residents of the Bikini Atoll have been debating return provisions, rehabilitation plans, and compensation. The Nuclear Claims Council decided in March to award the people of Bikini $563 million in compensation for loss of value, restoration costs, and suffering and hardship.

Frank Schumacher

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Birkigt, Marc (1878–1953)

Born in Geneva in 1878; studied there at the Ecole des Arts et Métiers. In 1899, he started working in Barcelona, where he launched the Hispano-Suiza firm in 1904, which quickly became an important car maker. In 1913, another one was built at Bois-Colombes in France, but its workers had to join the front in August 1914. Back in Spain, Birkigt designed a 150-hp aviation engine in October 1914. This revolutionary V-8 engine was accepted by a French committee in July 1915. Nearly 50,000 derivatives were ordered by Allied countries in three basic versions: 180-hp, 220-hp, and the Cannon engine. From 1923, Birkigt designed many aircraft engines giving 350 hp to 1,000 hp at the start of World War II. In 1936, he had to stop producing his legendary cars to concentrate on cannons and the 12Y engine that was used in great number. This mechanical genius died in Switzerland in 1953.

Stéphane Nicolaou

Bishop, William (1894–1956)

Canada's "Ace of Aces" during World War I; achieved the rank of Air Marshal in the British service. William "Billy" Bishop was studying at Canada's Royal Military College when he went to war in 1914. Dissatisfied with ground fighting, he transferred to flying the next year. Wounded as an observer, he retrained as a pilot and was assigned to Royal Flying Corps No. 60 Squadron in April 1917, where he ran his score to 47 before going back to England that summer. This tour is best remembered for his claimed solo raid on a German airfield on 2 June 1917. That action won him the Victoria Cross, but the lack of supporting evidence in German records for this and many other Bishop exploits has caused the accuracy of his record to be hotly contested. During this brief tour, his score climbed to 72, the highest number of claims by any pilot in British service.

James Streckfuss

See also

Royal Aircraft Factory; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Bismarck, Air Operations Against the

Destruction of Germany's greatest warship. Although the German battleship *Bismarck* was eventually sunk by gunfire and torpedoes from British surface ships, it was aircraft reconnaissance and attacks that doomed the formidable ship. In May 1941, the *Bismarck* and the cruiser *Prinz Eugen* slipped into the Atlantic to raid British commerce. British capital ships intercepted them but were driven off with the loss of HMS *Hood,* but not before causing minor damage to the *Bismarck.* This damage prompted *Bismarck* to alter plans and attempt to return to France for repairs. Later, Swordfish torpedo-bombers from the *Victorious* hit the *Bismarck,* causing the first German fatality but no appreciable damage. *Bismarck* broke contact after covering *Prinz Eugen*'s escape but was spotted by a British Catalina. Swordfish from HMS *Ark Royal* torpedoed and disabled *Bismarck's* rudder, allowing surface ships to close in and finish the battleship. The destruction of the *Bismarck* illustrated the vulnerability of surface ships to air attack, even from obsolescent aircraft.

Grant Weller

See also

Aircraft Carriers, Development of; Atlantic, Battle of the; Consolidated PBY Catalina; Fairey Aircraft

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Bismarck Sea, Air Battle of (1943)

Destruction of Japanese convoy off New Guinea. On 1 March 1943, a Japanese convoy of eight transports and eight escorts left Rabaul, New Britain, bound for Lae, New Guinea, with troops and supplies. Allied intelligence analysis had accurately predicted the operation and Allied reconnaissance aircraft soon spotted and tracked the convoy. The ships came under attack from U.S. B-17s, B-25s, and P-38s, along with Beauforts, Beaufighters, and Bostons of the Royal Australian Air Force, all flying from Port Moresby and other bases in the Southwest Pacific. For weeks the Allies had practiced such missions and had modified many of their aircraft to increase their effectiveness against surface naval targets.

The Japanese were unable to effectively contest control of the air over the convoy, and Allied aircraft continued to launch devastating attacks over several days until all eight transports and five escorts were sunk. Only a few survivors from the transports reached the convoy's destination in New Guinea. The Japanese ceased to attempt regular supply convoys to eastern New Guinea, sealing the fate of the Imperial army in that area.

The battle again illustrated the difficulties of conducting naval operations in the face of enemy air superiority and the beneficial effects of intense mission-specific training and rehearsal.

Frank E. Watson

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Bissell, Clayton L. (1896–1973)

Major general in the U.S. military. Born in Kane, Pennsylvania, Clayton Lawrence Bissell was among America's earliest military aviators. After earning a law degree in 1917 from Valparaiso University, Indiana, he enlisted and was commissioned (January 1918) in the Aviation Section of the U.S. Army Signal Corps Reserve. After initial training at Mohawk, Canada, he was assigned to Taliaferro Field, Texas, in November 1917. Sent to England, he trained with the 22d Aero Squadron and served in the Overseas Ferry Service before joining the 148th Aero Squadron in July 1918. Bissell destroyed five enemy planes, becoming an ace. Commanding the 638th American Fighter Squadron, he was promoted to captain in March 1919.

Captain Bissell returned to the United States and was assigned to Kelly Field, Texas, to command the 27th Aero Squadron and the Air Service Group. In June 1920, he went to Washington, D.C., as chief of the Tactical Operations Section in the Office of Air Service, and in December he was enrolled in the Air Service Field Officers' School at Langley Field, Virginia. Upon completion in June 1921 he served as flight commander of the 14th Squadron at Langley, and later instructed in the Air Service Field Officers' School.

Assigned to Washington, D.C., in November, Bissell served as assistant to Brigadier General William Mitchell for four years. Following a one-year posting with a round-the-world flight to British Columbia, Alaska, the Aleutians, Greenland, Labrador, Newfoundland, and the Maritime Provinces, he returned to Langley Field in December 1924 to serve as secretary of the Air Service Board. After instructing at the Air Corps Tactical School at Langley Field (September 1926–August 1931), Bissell studied at the Command and General Staff School at Fort Leavenworth, Kansas, followed by study at the Army War College and then the Chemical Warfare School at Edgewood Arsenal, Maryland, completing his studies in July 1934. Captain Bissell completed a tour with the 18th Pursuit Group at Schofield Barracks, Hawaii, as intelligence and operations officer, and then as commanding officer. He was promoted to major and returned to the mainland in July 1938 to attend the Naval War College at Newport, Rhode Island. In July 1939, he joined the War Department General Staff as a member of the War Plans Division.

In January 1942, Colonel Bissell joined Major General

Joseph W. Stilwell's staff in China and commanded all U.S. air forces in India, Burma, and China. As a brigadier general (21 April 1942), Bissell commanded the Tenth Air Force in India and Burma after the Fourteenth Air Force in China was activated under Claire L. Chennault. Bissell returned to the United States as a major general in August 1943 and became assistant Chief of Air Staff for intelligence at Air Force HQ in Washington. He later served the Office of the Assistant Chief of Staff for Intelligence on the War Department General Staff and was active in the Joint Security Control, the Joint Intelligence Committee, the Combined Intelligence Committee, and the psychological warfare program; he headed the War Department's historical program.

Bissell became military attaché to Great Britain in May 1946 and returned to the United States in October 1948. Posted to Headquarters U.S. Air Forces in Europe, at Wiesbaden, Germany, he returned to Washington in April 1950. General Bissell was awarded the Distinguished Service Cross, Distinguished Service Medal with two Oak Leaf Clusters, Silver Star, Distinguished Flying Cross and Air Medal, the British Distinguished Flying Cross, and several other foreign decorations. General Bissell retired from the USAF on 30 October 1950 and died on 1 January 1973.

Richard C. DeAngelis

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Blackburn Aircraft

The Blackburn Aeroplane and Motor Co. Ltd. was formed in June 1914 to build the Royal Aircraft Factory B.E.2c that was adopted as standard equipment for the fledgling Royal Flying Corps and Royal Naval Air Service. During World War I, the company built a total of 111 of B.E.2s, developed the Sopwith Cuckoo torpedo-bomber (132 built) and built the Sopwith Baby seaplane in quantity (186) for the British Admiralty.

During the lean interwar years, Blackburn designed and built a variety of naval and civil aircraft, and specialized in torpedo-bombers such as the Dart, Ripon, and Shark. The Skua was a two-seat naval fighter/dive-bomber built to Air Ministry specification O.27/34. The prototype first flew in February 1937, but the need for a carrier-borne dive-bomber was so urgent that 190 aircraft were ordered six months before the prototype flew. The Skua was rather underpowered for a fighter but enjoyed some success in the first months of the war, including the successful dive-bombing of the German cruiser *Königsberg* in Bergen Harbor on 10 April 1940. The Skua (190 built) was withdrawn from front-line service in August 1941 and was relegated to training and target-towing duties.

The Botha was a twin-engine land-based reconnaissance and torpedo-bomber developed to the same specification as the Bristol Beaufort. The specification was amended to include four crew members (rather than three), and it became clear that more power was required. Unfortunately, no Bristol Taurus radials were available for the program, so the aircraft went into production with the Bristol Perseus motor. A total of 580 were built. The Botha served with RAF Coastal Command during the first year of World War II and was relegated to training duties from the end of 1940.

During the war, Blackburn Aircraft built 1,700 Fairey Swordfish, 635 Fairey Barracuda Mk IIs, and 250 Short Sunderland aircraft under license.

The Firebrand first flew in February 1942. A total of 220 of all marks were built. The Firebrand was originally designed as a single-seat naval fighter, but following the adoption of the Supermarine Seafire as the standard Fleet Air Arm (FAA) fighter, it was redesigned as a high-performance torpedo-bomber after the first dozen fighters were built. Many early marks were used for trial purposes, and the Firebrand was in operational service from September 1945 to August 1953.

Blackburn was amalgamated with General Aircraft Ltd. on 1 January 1949 as Blackburn and General Aircraft Ltd. The Blackburn Beverley (47 built) was a General Aircraft design under an Air Ministry specification for a medium-range tactical transport. A total of 47 served with RAF Transport Command from 1956 to 1967, when they were replaced by the Lockheed C-130K "Hercules."

The Buccaneer was a two-seat low-level naval strike aircraft and first flew in July 1958. It was built to withstand the rigors of high-speed low-level flight and incorporated a number of structural and aerodynamic advances. It was capable of delivering nuclear or conventional weapons and was the first operational aircraft to be fitted with a head-up display. The first operational squadron, No. 801, embarked on HMS *Ark Royal* in February 1963.

The Buccaneer was pressed into RAF service as a replacement for the canceled General Dynamics F-111K, and the first unit (No. 12 Squadron) formed at RAF Honington in October 1969. With the run-down of the FAA's conventional carrier force, all surviving Buccaneers were transferred to the RAF during 1978.

The Buccaneer received numerous upgrades and modifications to its electronic systems and weapons fit throughout its service life, include laser-guided bomb delivery and designation using the Pave Spike system. During the 1991 Gulf War, Buccaneers were used to provide target designation services for Tornados following the RAF's abandonment of JP233 airfield attacks. A total of 189 production Buccaneers were built.

Blackburn Aircraft became a member company of the Hawker-Siddeley Group in May 1963.

Andy Blackburn

See also

Fairey Aircraft; Fleet Air Arm; General Dynamics F-111 Aardvark; Gulf War; Gun Sights; Short Sunderland; Supermarine Spitfire

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Blériot Aircraft

French aircraft manufacturer. Dealing himself into the growing company of early aviators in 1908 with an unsuccessful ornithopter design, Louis Blériot continued working until he finally achieved aerial immortality by being the first to fly across the English Channel. The flight was made in the Blériot 11, a delicate-looking monoplane with a partially open fuselage, powered by an Anzani engine of 25 hp. For the next few years and into the war, the fortunes of Blériot Aéronautique were built on the Type 11, which served in French, British, and Russian units performing reconnaissance and light bombing duties.

As the war progressed, the Type 11 was surpassed technologically by more modern designs, but it continued to serve in the French training schools both as a flying machine and in a not-quite-flyable role as a clipped-wing Penguin. Using Penguins, French student-pilots would conduct high-speed taxi runs to learn the feel of the aircraft's controls.

In 1913, Blériot acquired Armand Deperdussin's firm (Société Provisoire des Aéroplanes Deperdussin), which had produced SPAD aircraft. He retained the chief engineer, Louis Bécherau, and changed the firm's name to Société Anonyme pour l'Aviation et ses Dérives to retain the SPAD name. The SPAD fighters became France's main combat aircraft and served with other countries as well. His original Blériot firm continued production with a series of very large, very complex designs that were not adopted for general use.

James Streckfuss

See also

SPAD Aircraft

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Blimps, Military Use of

Nonrigid airships for observation and gathering intelligence. The development of both the internal combustion engine and the dirigible balloon, or rigid airship, dates from the late 1800s and opened up even more military possibilities for their use. Large rigid and nonrigid airships were deployed offensively and defensively during World War I.

Count Ferdinand von Zeppelin, a pioneer in airship construction, developed large rigid airships prior to World War I that were used by the German army and navy. Nonrigid airships were also used during World War I by the Allies as a response to the German U-boat threat.

The nonrigid airship, or blimp, as it came to be called, soon proved its worth during the conflict patrolling the English Channel, Irish Sea, and the North Sea against submarines and scouting for mines. In all, the British built 374 blimps for service during the war. The primary advantage of the blimp compared to a heavier-than-air craft was its range. The British type C (Coastal), for example, carried a crew of five, mounted a machine gun, and had a speed of 50 mph; its endurance was more than 24 hours, which allowed a substantially wider radius of action than conventional aircraft. The United States Navy, aware of British successes with blimps, purchased more than 16 nonrigid airships from Goodyear between 1917 and 1918; they flew a total of 13,600 hours on antisubmarine patrols over the North Atlantic and bombed two German U-boats.

Following the war, Goodyear saw a role for blimps in the advertisement field. But blimps also continued to play a role in the military. Using helium as a substitute for flammable hydrogen ensured the survival of blimps for the foreseeable future. The United States was the only natural source of helium, and it became a world leader in the design and construction of nonrigid airships.

Blimps continued to increase in size, speed, and capacity by the outbreak of World War II. The Goodyear K class, the mainstay of the USN airship fleet, carried an eight-man crew and had a maximum speed of 77 mph with a range of 2,000 miles. The K class could carry four bombs, and later models were equipped with airborne radar for antisubmarine warfare operations. Goodyear built 135 K-class blimps for the USN before the end of the war.

USN blimps carried out a number of tasks during the war, including long-range air patrols, convoy protection, performing search-and-destroy missions, and directing surface ships in their searches for German submarines.

During World War II, the USN employed some 200 blimps in trade-protection duties primarily off the East Coast of the United States; some blimps saw service in the West Indies, Brazil, and in the Mediterranean. Following the end of World War II, the USN slashed the number of blimps in its inventory.

In the late 1950s, however, USN blimps, of the ZPG class, took on a new role when they became part of the North American Air Defense system's early warning chain. Equipped with airborne early warning radar (AEW), USN blimps patrolled off the U.S. East Coast for up to two weeks at a time, thereby extending the range of land-based radar. The completion of the distant early warning radar chain and the introduction of long-range fixed-wing patrol craft in the 1960s spelled the end of USN blimps. In 1962, the last were withdrawn from service; they were reverted to a commercial role.

Shawn Cafferky

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Blitzkrieg

Concentrated application of Luftwaffe close air support and interdiction for rapidly advancing field columns. In World War I, the German army had gained valuable, though limited, expertise with the concept of aerial support of ground forces. The U.S. Marine Corps's post-1918 experiences in Nicaragua and the U.S. Navy's and Royal Air Force's dive-bombing trials also indirectly influenced German aviators' thinking in the 1920s.

Secret facilities at Lipetsk in the Soviet Union further allowed the German army to test aircraft types and operational doctrine banned by the Treaty of Versailles. By the time of the Nazis' rearmament program and the first major statement of German aerial doctrine—*The Conduct of Aerial War* (1935)—the Luftwaffe had as one of its missions the direct support of the army and navy. That particular role influenced the types of aircraft procured.

When war broke out in 1939, the Luftwaffe was primarily tasked to gain battlefield aerial supremacy, act as "flying artillery," deliver airborne forces, and interdict the enemy's movement in the hinterland. For the first mission, the Luftwaffe employed Messerschmitt Bf 109s. The flying artillery was provided principally by the ungainly but justly famous Junkers Ju 87 "Stuka," whose name became a synonym for German dive-bombers. Less famous, but nonetheless valuable, the Henschel Hs 123 biplane served in the ground attack role. Rugged and regarded fondly by its pilots, the Hs 123 would soldier on into 1944.

Paratroops flew in the similarly venerable Junkers Ju 52, affectionately known as "Auntie Ju." For aerial interdiction the Luftwaffe fielded large numbers of twin-engine types. These included the extremely versatile Heinkel He 111 and the Dornier Do 17 "Flying Pencil."

In Poland, Germany deployed some 1,600 aircraft, including nearly all 335 available Ju 87s. Quickly gaining aerial supremacy, the Luftwaffe devastated pockets of Polish resistance, most notably that of the Poznan Army in the Bzura River Cauldron.

Later, in May 1940, the Luftwaffe had more than 4,000 aircraft available for the campaign in the West, among them 380 dive-bombers and 475 troop transports. Again it gave another extraordinary demonstration of airpower in blitzkrieg. On 10 May 1940, German paratroops dropped onto the roof of Eben Emael, a crucial Belgian fortress, to seize it for advancing columns. Several days later, on 13–14 May, scores of Ju 87s blasted French defenders along the Meuse River near Sedan, allowing Panzer grenadiers to effect a major crossing of that strategic obstacle. In addition, German fighters annihilated British bombers sent to attack the bridgehead. At month's end, Luftwaffe level and dive-bombers harassed the Royal Army and Royal Navy unmercifully as they executed their desperate evacuation from Dunkirk. These and other victories established the Luftwaffe's fearsome reputation as the aerial arm of lightning war.

Although defeated in the Battle of Britain, the Luftwaffe went on to enjoy smaller-scale successes in the Balkans in early 1941. Staggering victories over an initially inept Red Air Force followed. Regardless of the defeats to come, the early blitzkrieg triumphs in Poland and France conveyed the sense of overwhelming might.

D. R. Dorondo

See also

Balkans, Air Operations; Britain, Battle of; German Air Force (Luftwaffe); Heinkel Aircraft; Junkers Aircraft; Messerschmitt, Willy

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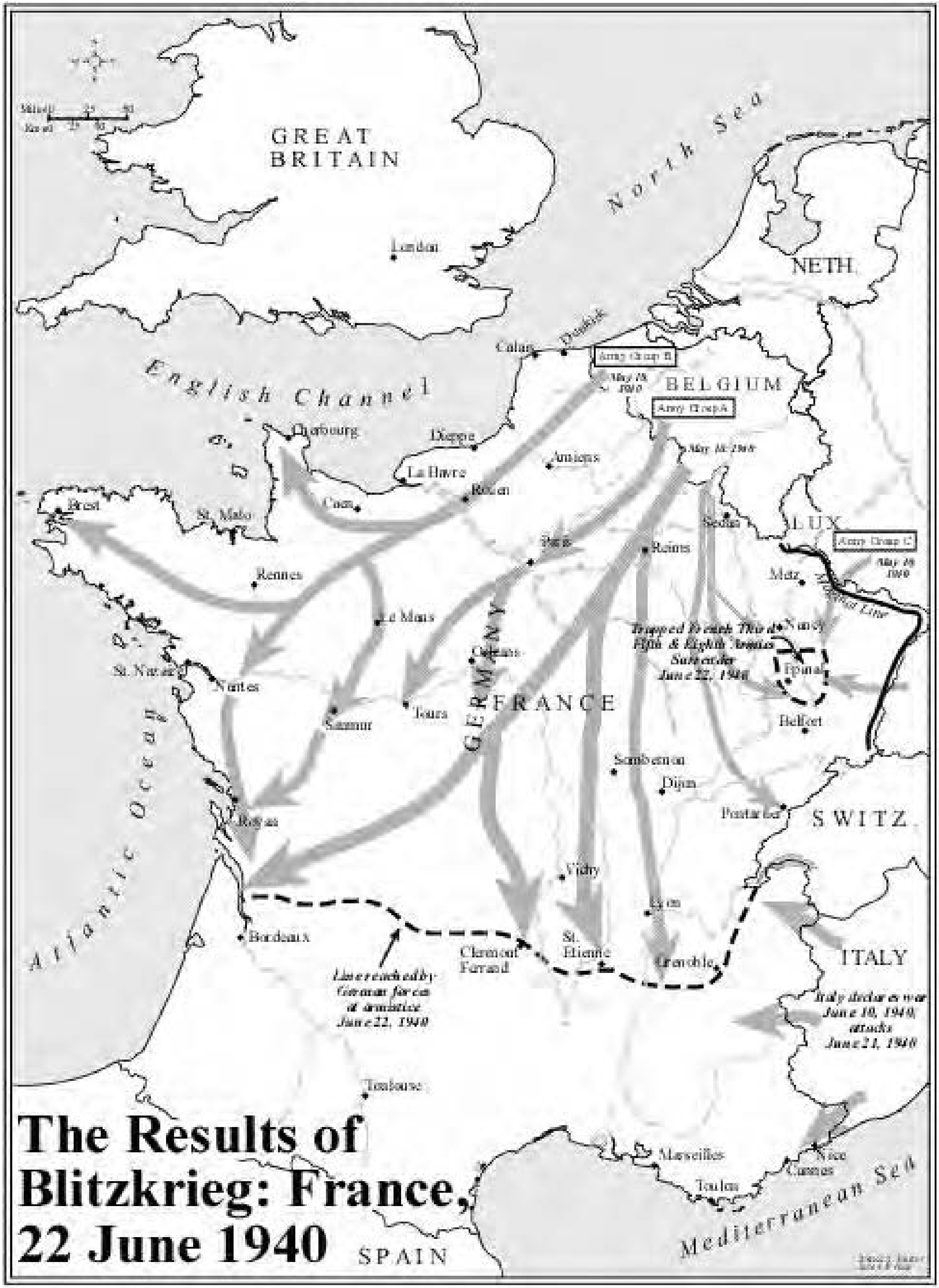

GREAT BRITAIN
North Sea
London
NETH.
English Channel
Calais
Army Group B
BELGIUM
Army Group A
Cherbourg
Dieppe
Amiens
La Havre
Rouen
Caen
Brest
St. Malo
Sedan
LUX.
Army Group C
Paris
Reims
Rennes
Metz
Maginot Line
Nancy
Le Mans
Trapped French Third, Fifth & Eighth Armies Surrender June 22, 1940
Orleans
Epinal
St. Nazaire
Nantes
GERMANY
FRANCE
Tours
Saumur
Belfort
Dijon
Pontarlier
SWITZ.
Royan
Atlantic Ocean
Vichy
Lyon
Bordeaux
Clermont Ferrand
St. Etienne
Grenoble
ITALY
Line reached by German forces at armistice June 22, 1940
Italy declares war June 10, 1940; attacks June 21, 1940
Toulouse
The Results of Blitzkrieg: France, 22 June 1940
Marseilles
Toulon
Nice
Cannes
Mediterranean Sea
SPAIN

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Blohm and Voss Aircraft

Created in 1933 as a subsidiary of a shipbuilding firm established in 1877. The Hamburger Flugzeugbau GmbH (Hamburg Construction Company) was established to develop and manufacture aircraft. Richard Vogt was lured from Kawasaki to become chief designer.

The first aircraft, a biplane trainer, was rolled out in mid-1934. Manufacture of subassemblies and of other companies' aircraft under license proceeded apace, and a new factory and airfield were opened in September 1935. The Bv 138 three-engine flying boat, often dubbed the "Flying Shoe" for the shape of its fuselage, first flew in 1937 and, with 276 manufactured, was the only company design to achieve mass production. It was widely used for reconnaissance and minesweeping duties during the war. Three Ha 139 four-engine floatplanes followed for Lufthansa Airline transatlantic mail runs and wartime reconnaissance work. Nine Bv 141 asymmetric aircraft were used for observation duties on all fronts.

The first of two huge flying boats initiated by Lufthansa was the Bv 222 Wiking (Viking) with six engines. First flown in 1940, it was the largest operational flying boat of the war when it entered service in 1942. The Bv 222 aircraft were used for troop-carrying and freight and at least one long-distance mission to Japan. The even larger Bv 238 (which first flew in early 1944 with six engines on nearly 200-foot wings) was the heaviest aircraft in the world at the time. Only one model was completed, and it was destroyed in an Allied air attack just days before the war ended; two others were never completed.

Christopher H. Sterling

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Bock's Car

Bomber that dropped the atomic bomb on Nagasaki. On 9 August 1945, Major Charles Sweeney, pilot of the Boeing B-29 named *Bock's Car,* dropped the second atomic weapon (code-named "Fat Man") on the city of Nagasaki, Japan. The order explicitly stated that while radar could be used as an aid, the "crew was to bring the bomb back to base" if the target could not be dropped visually.

After the first atomic bomb was dropped on Hiroshima on 6 August, U.S. commanders wanted a second bomb dropped as soon as possible to convince the Japanese that the United States had a huge arsenal of such weapons. Kokura was the primary target, but bad weather dictated going to the backup target, Nagasaki. Soon after the detonation of the second weapon, the Japanese government surrendered, eliminating the need for an Allied invasion and saving hundreds of thousands of American and possibly millions of Japanese lives.

Henry M. Holden

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Boeing (McDonnell Douglas/Hughes) AH-64 Apache

Developed as a replacement for the cancelled AH-56 Cheyenne, the Hughes Model 77 was selected over the competing Bell AH-63. The first prototype made its maiden flight on 30 September 1975, and production deliveries began in January 1984. McDonnell Douglas purchased Hughes Helicopter on 6 January 1984 and subsequently merged with Boeing in 1998. More than 1,000 Apaches have been delivered, and production continues. The Apache is in service with the U.S. Army, Egypt, Greece, Israel, Netherlands, Saudi Arabia, United Arab Emirates, and the United Kingdom.

The AH-64 fleet consists of two models, the AH-64A and the newer AH-64D Longbow Apache. The Longbow fire-control radar provides the ability to detect, classify, and prioritize stationary and moving targets both on the ground and in the air. The AH-64 is powered by two 1,890-shp General Electric T700 gas-turbine engines; it has a top speed of 182 mph and a range of 300 miles.

Dennis R. Jenkins

See also

Bell AH-1 Cobra

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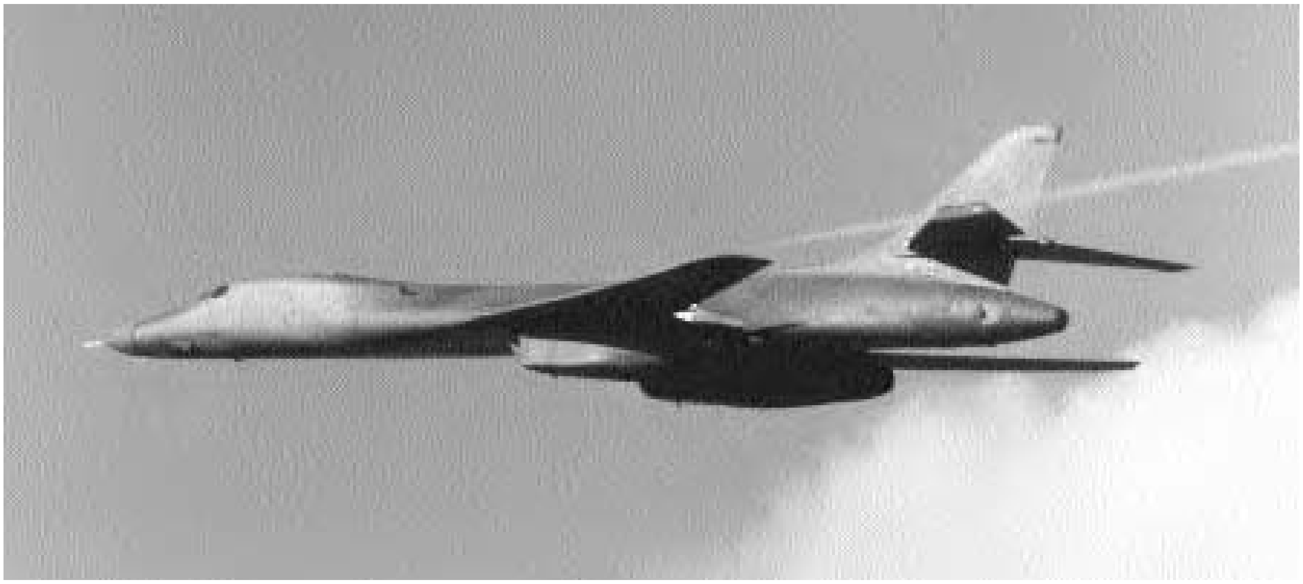
Boeing (North American Rockwell) B-1B Lancer

A four-engine long-range multirole heavy bomber capable



The Boeing B-1B had a long period of development but has proved its efficiency in the war on terrorism, where the bomber has become the primary weapon. (U.S. Air Force)

of supersonic flight and capable of carrying nuclear bombs. The B-1B holds 61 world records for speed, payload, and distance. Originally manufactured by North American Rockwell, it holds the world record for the fastest round-the-world flight (36 hours, 13 minutes).

The B-1B is similar in shape to the four B-1A prototypes built in the 1970s. The first operational B-1B was delivered to the U.S. Air Force at Dyess Air Force Base, Texas, in June 1985. The final B-1B was delivered on May 2, 1988. Its armament includes eight AGM-86B cruise missiles mounted internally plus four externally, 24 AGM-69 SRAM internally plus 14 externally, and 24 B61 or B83 special weapons.

B-1B Lancers flew 74 combat missions in Kosovo and dropped more than 5,000 conventional bombs.

Henry M. Holden

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Boeing B-17 Flying Fortress

Legendary U.S. bomber that served in every theater of World War II. In May 1934, the U.S. Army Air Corps announced a competition for a new multiengine bomber. Each entrant was to be funded by the manufacturer and flown to Wright Field near Dayton, Ohio, for evaluation in late 1935. Douglas Aircraft decided to adapt its DC-2 transport into a stubby, deep-fuselage aircraft called the DB-1 (for Douglas Bomber One). Boeing, with the concurrence of the Air Corps, opted for a brand-new four-engined airplane, identified as the Model 299. It was based on the structural design of the Model 247 airliner along with the military features and engine arrangement of the XBLR-1, or future XB-15.

On 26 September 1934, Boeing's board of directors appropriated a sum of $275,000—nearly half the company's cash assets—for the project. The company would expend 153,080 engineering man-hours on the preliminary design of the Model 299. Eventually, the design costs would rise to $660,000. The airplane rolled out of Boeing's Plant 2 factory in Seattle, Washington, on 17 July and made its first flight on 28 July 1935.

During the flyoff the Boeing entry crashed as a result of the elevator control lock not being removed. The Army contract was awarded to Douglas for the production of 75 aircraft designated the B-18 Bolo. The crash of the Model 299 also resulted in the development of the flight-crew checklist—a feature found on almost every subsequent airplane. Continuing Air Corps interest in the Boeing entry led to the production of 12,726 B-17s, most by Boeing but also by Lockheed-Vega and Douglas.

The B-17 was powered by four Wright R-1820 engines. It had an 8,000-pound bombload, a service ceiling of 35,600 feet, and a range of 2,000 miles. Manned by a crew of 10, the aircraft mounted 13 .50-caliber machine guns for defensive armament.

Alwyn T. Lloyd

The demands of air combat caused many modifications to be made to Boeing's B-17, and among the most important of these was defensive firepower. This B-17G packed a powerful forward-firing turret to offset German frontal attacks. (U.S. Air Force)

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Boeing B-29 Superfortress

U.S. strategic bomber during World War II; dropped the first atomic bombs. When Boeing designers began developing the B-29, the basic problem confronting them was how to propel a mass that was twice as heavy as the B-17 twice as fast. To meet this challenge, extremely powerful engines would be required. The B-29s were powered by Wright R-3350 Cyclone engines capable of developing 2,200 horsepower. The R-3350, however, was not fully developed and caused many problems for the B-29.

Boeing worked to reduce airplane drag in 13 critical areas, providing a combination of good landing and flight characteristics. A streamlined fuselage with enclosed defensive armament positions and a high-aspect ratio wing enabled high performance. The B-29 was also the first pressurized bomber.

The aircraft were based in China and later the Mariana Islands, where they brought the war to the Japanese homeland. Two of these aircraft dropped the atomic bombs on Japan, bringing World War II to a close.

Four factories built 3,965 B-29s. They served again during the Korean War and in a variety of post–World War II roles.

Alwyn T. Lloyd

See also
Boeing B-17 Flying Fortress

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Boeing B-47 Stratojet

Early U.S. jet bomber; predecessor of the B-52. When the U.S. Army Air Forces issued a requirement for a jet bomber in 1944, four manufacturers presented proposals. Boeing's design for the B-47 won for a number of reasons but especially because it was capable of carrying the outsized nuclear weapons of the day. It took five years of intensive testing to get the airplane ready for service. The range of the B-47 was a limiting factor from the outset. To overcome this deficiency, external fuel tanks and an inflight refueling system were added.

The B-47 became the cornerstone of the U.S. nuclear deterrent force until the B-52 came into the inventory. At the peak of its career, 1,365 B-47s were in Strategic Air Command's (SAC) inventory of 1,650 bombers. These aircraft never dropped a bomb in anger.

SAC initially deployed entire B-47 wings around the world to bases that were closer to the Soviet Union. Later, SAC deployed several B-47s from various wings to the forward operating areas in an effort to reduce the strain on the crews and their families.

Some authorities believe the B-47 to be the most important multijet engine aircraft in history because it sired the Boeing line of aircraft that included not only the KC-135 tanker and B-52 bomber but also the 707, 727, 737, 747, 757, 767, and 777 transports.

Alwyn T. Lloyd

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Boeing B-52 Stratofortress

U.S. strategic bomber in service for a half-century. Boeing won a preliminary design contract over Convair in 1946 to design a new intercontinental strategic bomber. The B-52 first flew on 15 April 1952 and entered an extensive flight-test and service-evaluation program. Although 744 B-52s were built, the maximum number in service was 639 in 1962.

The aircraft served in Strategic Air Command as the mainstay of the nuclear deterrent force for more than 30

This photo, taken from the boom operator's position of a Boeing KC-135, represents a routine event that nonetheless takes tremendous skill: the refueling of a Boeing B-52 bomber. (U.S. Air Force)

The most important multijet aircraft in history, the Boeing B-47 enabled Boeing to become a dominant factor in both military and commercial aircraft production. (Walter J. Boyne)

Refueling a six-jet Boeing B-47 from a six-engine (four-piston, two-jet) Boeing KC-97 was no easy task, for the tanker had to fly at top speed, sometimes in a descent. As you can tell from the nose-up attitude of the B-47, it is flying as slow as it can and still not stalling. (U.S. Air Force) years and continues to be a major asset in the strategic arena. During more than a decade of war in Vietnam, B-52s traded their nuclear mission for a conventional role. B-52Ds were modified under the Big Belly program and were able to carry up to 108 750-pound bombs. During the Christmas bombings over North Vietnam in 1972, B-52s were credited with finally bringing the enemy to the peace table. Of the 33 B-52s lost in Southeast Asia, 15 went down during Operation LINEBACKER II. B-52s dropped the greatest tonnage of iron bombs during the Gulf War; the war opened with seven B-52Gs flying a 35-hour round-trip mission to launch conventional cruise missiles.

Originally designed as a high-altitude bomber, the B-52 gradually became a low-level penetrator to avoid enemy radar. At first the B-52s flew at 500 feet, then with improved avionics were capable of flying at 400 knots 200 feet above ground level. Given that the airplane had a 185-foot wingspan, such flight was extremely challenging.

The B-52 has the distinction of having served three generations of aircrews. Now down to less than 100 B-52Hs, Air Combat Command expects to operate the aircraft until at least 2020.

Alwyn T. Lloyd

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Boeing (McDonnell Douglas) C-17 Globemaster III

The Boeing (formerly McDonnell Douglas) C-17 "Globemaster III" is the newest U.S. Air Force cargo airplane. It is 174 feet long and has a 170-foot span. It is a fly-by-wire aircraft that can carry payloads of 172,000 pounds at 41,000 feet and an airspeed of 575 mph. There are three crewmembers: pilot, copilot, and loadmaster. The cost-effective flight crew is made possible through the use of an advanced digital avionics system using four cathode-ray tube displays, two full-capability head-up displays, and advanced cargo systems.

The C-17 can take off and land on runways as short as 3,000 feet (914 meters) and as narrow as 90 feet (27.4 meters). Even on such narrow runways, the C-17 can turn around using a three-point star turn and its backing capability.

During normal testing, C-17s set 22 world records, including payload to altitude time-to-climb, as well as the short takeoff and landing mark in which the C-17 took off in less than 1,400 feet, carried a payload of 44,000 pounds to altitude, and landed in less than 1,400 feet.

In 1998, eight C-17s completed the longest airdrop mission in history, flying more than 8,000 miles from the United States to Central Asia, dropping troops and equipment after more than 19 hours in the air.

Henry M. Holden

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Boeing Aircraft

Major U.S. aircraft manufacturer founded by two friends: William E. Boeing, a prominent Seattle lumberman, landowner, and yachtsman; and Commander Conrad Westervelt, who headed the U.S. Navy shipyard in Seattle. They formed an informal partnership in 1914, and within two years their idea grew into the Pacific Aero Products Company. They decided to get into the aircraft business and purchased a Martin seaplane. Trials and tribulations with the Martin airplane gave them insight into how to do things better. Westervelt had given Boeing flying lessons. Between them they designed the company's first product—the Boeing and Westervelt seaplane. Boeing embarked on building several other seaplanes and started an air mail service between Vancouver, Washington, and Vancouver, British Columbia.

Boeing received a post–World War I contract to refurbish de Havilland DH-4 biplanes for the U.S. Army. Subsequent government contracts brought a series of pursuit airplanes for both the Navy and the Army. Several Boeing-designed airmail airplanes were also produced. In 1928 came the Model 80, a 12- or 18-place enclosed trimotor biplane that was employed on the Chicago–San Francisco route.

Boeing experimental aircraft led to the Model 247, the first twin-engine all-metal transport. This transport dominated the market until the advent of the Douglas DC-1 and DC-2.

During this period Boeing was part of a business empire known as United Aircraft and Transport Corporation, joining Boeing, the airframe designer/manufacturer; Pratt and Whitney, the engine builder; Hamilton Standard, producer of propellers; and a host of airlines, including Boeing Air Transport and United Airlines. This synergistic organization was disbanded as part of the Air Mail Act of 1934, under which the design and manufacturing operations were separated from the airline operations.

In a company-funded effort, Boeing entered the U.S. Army Air Corps 1934 multiengine bomber competition with

When the Boeing (McDonnell Douglas) F-15 was being developed, the cry was "Not a pound [of weight] for air to ground" but the F-15 E gained a few pounds and became a stellar ground-assault aircraft. (U.S. Air Force)

a four-engine airplane—the Model 299, forerunner of the famous B-17 Flying Fortress. This heavy bomber set the stage for the company's reputation in building sturdy, reliable airplanes with performance to match. Later models included the B-29, B-50, B-47, and B-52 bombers and the KC-135 tanker. In addition, Boeing led the way with jet airliners, beginning with the 707 and continuing until today.

Boeing's prowess in space programs and its program management skills were singularly recognized when the company was placed in charge of the overall technical management of NASA's manned space programs after the fateful oxygen fire aboard one of the Apollo spacecraft in 1967.

In a series of mergers during the mid-1990s, Boeing acquired Rockwell Aviation in 1996 and the McDonnell Douglas Corporation in 1997. Incorporated in the state of Delaware, the company has undergone several name changes: Pacific Aero Products Company, Boeing Airplane Company, Boeing Aircraft Company, Boeing Airplane Company, and now the Boeing Company.

Alwyn T. Lloyd

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Boeing (McDonnell Douglas) F-15 Eagle

The F-15 was designed as a no-expenses-spared air-superiority fighter, and the first aircraft made its maiden flight on 27 July 1972. The F-15 quickly demonstrated it was far superior to existing fighters, although that capability was expensive to achieve. Israel ordered F-15A/Bs in addition to receiving some early test models. Slightly improved F-15C/Ds included a small amount of additional fuel and improved electronics. In addition to the United States, Israel and Saudi Arabia ordered the aircraft, and Japan set up its own production line for the substantially similar F-15J/DJ.

The F-15 proved to have a substantial air-to-ground capability, and the U.S. Air Force ordered the two-seat F-15E Strike Eagle into production as a replacement for the General Dynamics F-111 Aardvark. The first production F-15E made its maiden flight on 11 December 1986, and Israel and Saudi Arabia have ordered versions designated F-15I and F-15S.

The F-15 has seen a great deal of combat for a modern fighter, participating in several skirmishes at the hands of the Israeli Air Force and in Operation DESERT STORM with the air forces of the United States and Saudi Arabia. As of early 2000, the F-15 had scored more than 100 air-to-air kills against no air-to-air losses.

Dennis R. Jenkins

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There is no more demanding work than naval aviation, where the teamwork of air crew and deck crew is absolutely essential. Here Boeing F/A 18 Hornets prepare for a catapult takeoff. (U.S. Navy)

Boeing (McDonnell Douglas) F/A-18 Hornet

The Hornet is unique in that the basic design began as the U.S. Air Force Northrop YF-17 lightweight fighter prototype. After losing the competition to the General Dynamics F-16 Fighting Falcon, Northrop and teammate McDonnell Douglas won a U.S. Navy contract to develop a multirole fighter to supplement the Grumman F-14 Tomcat. The marriage was not always a happy one, and the teammates at one point sued one another over intellectual property rights concerning the marketing of the new aircraft.

The F/A-18 (the odd designation stands for fighter/attack) is equally adept at air-to-air missions or air-to-ground missions and proved it could perform both roles during the same mission during Operation DESERT STORM when a Navy Hornet shot down an Iraqi MiG while going on a strike mission.

The initial single-seat F/A-18As and two-seat F/A-18Bs were followed by improved F/A-18C/Ds that had greatly improved electronics. Australia, Canada, Finland, Kuwait, Malaysia, Spain, and Switzerland have all ordered versions of the Hornet. A total of 1,480 were manufactured.

In 1992, the U.S. Navy ordered an improved version—the F/A-18E/F. Although superficially similar, this is a much larger aircraft using a completely new airframe and engines. However, at least initially, the avionics are largely carried over from late-model F/A-18C/Ds. The Super Hornet also incorporates stealth technology to reduce its radar cross-section. The F/A-18E/F is expected to remain in production for the foreseeable future and will form the backbone of the U.S. Navy's air arm as the F-14 and earlier versions of the F/A-18 are retired.

Dennis R. Jenkins

The Boeing KC-10 tanker is employed for many specialized refueling jobs, including taking care of the Northrop B-2A. (U.S. Air Force)

See also

DESERT STORM

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Boeing (McDonnell Douglas) KC-10 Extender

U.S.-manufactured cargo and aerial-refueling aircraft. The KC-10 was the winner of the 1967 Advanced Cargo Tanker Aircraft competition against the McDonnell Douglas DC-10–30CF and the Boeing 747F. A new airplane was needed because the Lockheed C-5 Galaxy and L-1011 TriStar were out of production. On 19 December 1967, the contract was awarded to McDonnell Douglas.

The aircraft incorporated a new air-refueling boom that had a higher offload capability than the KC-135. The boom operator was seated on a bench in the rear of the aircraft. In addition, a hose drum unit can reel out a drogue for probe-and-drogue refueling.

The capacious cabin allows the aircraft to carry up to 27 standard cargo pallets. Several KC-10s are capable of carrying the War Reserve Spares Kits for an entire fighter wing; the KC-10 can then provide air refueling for the initial leg of a fighter-wing deployment. Coupled with KC-135s to provide en-route refueling for the KC-10s, an entire fighter wing can be deployed to anywhere in the world within 24 hours.

A total of 60 KC-10s were delivered to Strategic Air Command between 1981 and 1988.

Alwyn T. Lloyd

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Boeing KC-135 Stratotanker

U.S.-manufactured aerial-refueling tanker that entered service in the late 1950s. In conjunction with the U.S. Air

The most unsung and yet the most indispensable aircraft in the U.S. Air Force is the Boeing KC-135. This is an R model, with uprated engines. (U.S. Air Force)

Force, Boeing began the air-refueling business in earnest with the hose system, installing Air Refuelling Limited's equipment on B-29s. The system was retrofitted into 92 Superfortresses that were redesignated KB-29Ms; another 74 of the bombers were converted to be receivers and redesignated KB-29MRs. Marginal operational success was achieved.

Next, 116 Superfortresses were retrofitted with a Boeing-designed boom system and redesignated KB-29Ps, affording greater success. Strategic Air Command eagerly supported the boom-type refueling system because it allowed greater offload capability. The next-generation Boeing tanker was the Boeing KC-97 Stratofreighter, utilizing an improved flying boom. Of the 888 C-97s produced, 811 were delivered as KC-97E/F/G tankers. The larger aircraft carried an even greater fuel load than the KB-29s.

A direct outgrowth of the Model 367 Stratofreighter was the Model 367–80 prototype, which became the KC-135 Stratotanker. The Boeing identification for this next series of airplanes was Model 717, which was shorter and had a smaller fuselage diameter that the commercial 707 (the KC-135 flew a year earlier than the 707). The KC-135 incorporated further improvements to the boom. Of the 820 C/KC-135s produced by Boeing, 732 were tankers. Boeing build seven series of 135s, but subsequent modifications to the versatile airframe resulted in more than 40 series that can be identified by prefix and suffix.

Originally intended as a means to extend the range of bombers, the KC-135 became equally important to fighters and transports over the years. Beginning with the Vietnam War, no major USAF operation was possible without the extensive use of tankers. Like the B-52, the long-lived KC-135 will be in service for many years to come.

Alwyn T. Lloyd

See also
Boeing B-29 Superfortress

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Boeing-Vertol CH-47 Chinook

U.S. transport helicopter. Development of the CH-47 (Boeing Model 114/414) began in 1956 to meet a U.S. Army requirement for an all-weather medium transport helicopter. The first of five YCH-47As made its initial hovering flight on 21 September 1961, and more than 1,100 Chinooks have been manufactured in the United States, Japan, and Italy. They serve in the U.S. Army, as well as the armed forces of Argentina, Australia, Canada, Egypt, Greece, Iran, Italy, Japan, Libya, Morocco, Netherlands, Singapore, South Korea, Spain, Thailand, and the United Kingdom.

The Chinook can be configured to carry up to 33 combat troops or, alternately, for medical evacuation, 24 litters. In 1982, the original CH-47A, B, and C model Chinooks reached their 20-year service life and were remanufactured into CH-47D models. Now, as the D model approaches its 20-year service-life limit, plans are under way to again remanufacture the aircraft and insert a variety of new technology sensors and avionics.

Like most all Boeing-Vertol designs, the Chinook uses two counterrotating main rotors instead of the more conventional single main rotor and antitorque tailrotor. Power comes from two 3,750-shp Allied Signal T55-L-712s located above the aft fuselage on each side of the aft pylon. The CH-47D can fly at airspeeds up to 170 knots at a gross weight up to 50,000 pounds, including payloads of up to 26,000 pounds.

Dennis R. Jenkins

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Bolling Mission

Shortly after the U.S. declaration of war in World War I, in April 1917, a group under Major Raynal Bolling was dispatched to Europe to study and recommend what types of aircraft should be manufactured in the United States. Bolling was selected to head the mission due to his negotiating skills as a lawyer and his interest in aviation.

Visiting Britain, France, and Italy, the group recommended several types for production, but rapid technological advances in Europe and production delays in the United States combined to ensure that most aircraft used by the United States during the war would be purchased abroad. The major exception was the British de Havilland D.H.4, which was manufactured in the United States as the de Havilland DH-4 and which reached the front in August 1918 in time for combat.

James Streckfuss

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Boelcke, Oswald (1891–1916)

The father of fighter aviation, Oswald Boelcke started as regular army. Already a pilot when World War I began, Boelcke flew two-seaters until 1915, when he received one of the first Fokker "Eindeckers." Scoring early, he regularly competed for the leading spot with colleague Max Immelmann. Together they became the first airmen to win the Blue Max, but Immelmann's death in June 1916 prompted Boelcke's grounding. He returned to the front later that summer to mentor the pilots of Jasta 2. Running his score to 40, the first pilot to reach that number, Boelcke was killed on 28 October in a collision with one of his pupils, Erwin Boehme, when both swerved to avoid hitting Manfred von Richthofen. Boelcke is remembered as an outstanding teacher and considered by many to be the greatest fighter pilot of all time. His unit was renamed in his honor.

James Streckfuss

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BOLO (1967)

USAF code name for operation to lure North Vietnamese MiG fighters into combat. By December 1966, with Operation ROLLING THUNDER in full swing, Democratic Republic of Vietnam (DRV, i.e., North Vietnam) fighter-interceptors were becoming a major threat. Their tactics had become more aggressive and better coordinated with the introduction of a new ground-controlled interceptor (GCI) system and newer-model MiG-21s armed with Atoll infrared missiles.

Even so, President Lyndon B. Johnson would not allow (until April 1967) U.S. aircraft to attack enemy airfields near the Chinese border or in the suburbs of Hanoi for fear of killing civilians or Chinese advisers. The MiGs attacked in a fashion that forced U.S. aircraft to jettison their ordnance to meet the MiGs before reaching their targets. When U.S. planes attempted to engage the enemy, the DRV MiGs would retreat to their airfield sanctuaries.

To deal with this situation, Seventh Air Force officials devised a deceptive fighter sweep designated Operation BOLO. Designed to lure the MiGs into combat, the plan focused on the GCI's inherent inability to fully distinguish which aircraft the U.S. was deploying. The standard Air Force strike package included low-altitude Republic F-105 Thunderchiefs carrying bombs protected by high-altitude McDonnell F-4 Phantoms. In BOLO, F-4s assumed the identity of F-105s, including their electronic countermeasure emissions, attack patterns, and communications patterns. Republic F-105 Wild Weasels also provided suppression of enemy air defense as part of the operation.

The 2 January 1967 mission was led by Colonel Robin Olds of the 8th Tactical Fighter Wing (8th TFW). Plans called for simultaneous sweeps to enter the Hanoi target area from the east and west. The 8th TFW, based at Udon Air Base, Thailand, was to come in from Laos, while the 366th TFW, based at Da Nang, would attack from the Gulf of Tonkin.

Marginal morning weather delayed the operation until the afternoon, when three flights of F-4s from the 8th TFW reached the target. The first was led by Olds, the second by Lieutenant Colonel Daniel "Chappie" James, and the third by Captain John Stone.

After two passes over the Phuc Yen airfield, the MiG-21s attacked, expecting slow F-105s. An intense air battle lasted for 15 minutes, the largest aerial dogfight of the Vietnam War. The 12 F-4s shot down seven MiGs and had two probables. Olds was credited with two kills. The Americans suffered no losses.

Although limited in scope by the bad weather, BOLO was the greatest Allied aerial victory of the war. It destroyed nearly half of all the MiG-21s then in the DRV inventory, forcing their leaders to halt MiG operations just as the Americans had hoped. BOLO is generally acknowledged as one of the Air Force's greatest successes in Vietnam.

William Head

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Bong, Richard I. (1920–1945)

America's all-time leading fighter ace with 40 aerial victories over the Southwest Pacific during World War II; achieved the rank of major. A Poplar, Wisconsin, native born in 1920, Bong proved an unlikely hero. Once described as a "baby-faced cherub," he enlisted as an aviation cadet in 1941 and graduated in January 1942. After assignments as an instructor pilot at Luke Field, Arizona, and Hamilton Field, California, where Bong faced court-martial for "looping the loop" around the center span of San Francisco's Golden Gate Bridge, General George C. Kenney selected him as one of the first Lockheed P-38 pilots in the Fifth Air Force. On 27 December 1942, Bong scored his first two kills. By 8 January 1943, he was an ace.

After Bong topped Eddie Rickenbacker's legendary total of 26 victories, Kenney pulled the "innocent Norwegian boy" from combat and sent him to gunnery school. In October 1944, Bong resumed Fifth Air Force duty as a noncombatant gunnery instructor. Despite Kenney's mock orders to fire only in self-defense, Bong downed 12 more Japanese aircraft. Kenney recommended his favorite pilot for the Congressional Medal of Honor in December 1944. Worried about combat fatigue, Kenney ordered Bong back to the United States for a hero's welcome. Upon his return, Bong served as a test pilot for Lockheed's new P-80 jet aircraft. In this capacity, Bong died on 6 August 1945 in a crash, just hours after the dropping of the first atomic bomb. General Kenney's appreciation for Bong's skill, tenacity, and public relations value was shown by the Fifth Air Force commander's memoirs, *General Kenney Reports,* and Kenney's book *Dick Bong: Ace of Aces.* Many regarded Dick Bong as a link to the famed fighter aces of World War I, restoring a heroic human dimension to increasingly industrialized mass war.

John Farquahar

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Boulton Paul Aircraft

British aircraft manufacturer. Originally Boulton *and* Paul, the Norwich, England–based company had long specialized in structural engineering in both wood and steel, getting into aviation as a subcontractor during World War I.

Reorganized in 1934, the company moved to Wolverhampton to build the P.82 Defiant turret-equipped fighter that first flew in 1937. A low-wing, all-metal aircraft, its performance was severely limited by the size and weight of the power-turret machine gun installation. Still, more than 1,000 were built, with deliveries to active squadrons beginning in late 1939. Initially successful against Luftwaffe fighters, the plane soon lost its value when attacked from the front or beneath, where it was largely defenseless. The Defiant turned to the night-fighter role with some success, then finally to the air-sea rescue and target tug roles.

The P.108 Balliol advanced trainer flew in 1947 as the world's first single-engine turboprop aircraft. Subsequent models were equipped with Merlin piston engines; about 160 were built. The P.111 (1950) and P.120 (1952) were both delta-wing experimental jets. The company later specialized in powered flight controls for large military and civil aircraft, including fly-by-wire systems. Boulton Paul was acquired by Dowty in 1969.

Christopher H. Sterling

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Boyd, Albert (1906–1976)

As USAF major general, considered the father of modern USAF flight-testing; dramatically expanded the role of USAF test pilots.

Albert Boyd was born in Rankin, Tennessee, in 1906. For six years beginning in 1929, he was an Army flight instructor. Schooling in aircraft maintenance and engineering prompted assignments at Chanute Field, Illinois, in 1935 and the Hawaii Air Depot during World War II until his promotion to full colonel, and reassignment to Patterson Field, Ohio, in February 1943.

Boyd became deputy commander for the Eighth Air Force Service Command in Europe in July 1944. With Allied victory, he became chief of the Army Air Forces Flight Test Division at Wright Field, Ohio, in October 1945. Boyd understood that postwar flight-testing must exploit enhanced equipment and top-notch pilots to properly evaluate new aircraft that pushed aeronautical frontiers at an increasing tempo.

He interjected Air Force test pilots more squarely into the flight-test process than they previously had been. Up to that time, Air Force pilots were used to validate the findings of company test pilots and the research pilots of the National Advisory Committee for Aeronautics. In the postwar 1940s, Colonel Boyd placed handpicked Air Force test pilots in the cockpits of major projects, including the supersonic Bell X-1.

On 19 June 1947, Boyd set an absolute speed record of 623.608 mph in a modified Lockheed P-80R jet over Muroc (later Edwards) Air Force Base. By February 1952, after commanding Edwards, Boyd was appointed vice commander, and later commander, of the Wright Aeronautical Development Center. In July 1955, Boyd's final Air Force assignment was deputy commander for weapons systems at Headquarters, Air Research and Development Command. When he retired in 1957, General Boyd had logged more than 23,000 hours in 723 aircraft variants. He died in St. Augustine, Florida, in 1976.

Frederick A. Johnsen

Boyington, Gregory "Pappy" (1912–1988)

U.S. Marine Corps colonel; World War II fighter ace. Born in Coeur d'Alene, Idaho, on 4 December 1912, Gregory "Pappy" Boyington is perhaps the most famous U.S. aviator of World War II. In 1930, Boyington entered the University of Washington, where he earned a degree in aeronautical engineering. After a brief stint as a draftsman at Boeing in 1935, he joined the Marine Corps to fly military aircraft. By 1941, he had built a reputation as a highly skilled, if somewhat undisciplined, fighter pilot and was serving as a Marine flight instructor in Florida.

Only months before the Japanese raid on Pearl Harbor, Boyington resigned his commission to join the newly formed American Volunteer Group (the Flying Tigers), a small provisional air force organized to defend China from Japan. Boyington shot down several Japanese aircraft before quitting the group in 1942. Soon after, he rejoined the Marine Corps but did not see combat until later in 1943 when he assembled the makeshift Fighter Squadron 214. Known to history as the Black Sheep Squadron, it proved to be one of the most effective air combat units in the South Pacific, with Boyington alone destroying 22 Japanese planes. However, in January 1944 he was himself shot down and forced to endure 20 harrowing months in Japanese prison camps. Upon his release, he received the Medal of Honor and the Navy Cross; he retired from active duty in 1947 with the rank of colonel.

"Turbulent" is the word that best describes Boyington's life after his military service. He married and divorced twice, moved from job to job, and battled debt and alcohol problems. A significant high point arrived in 1958 when he published his memoir, *Baa Baa Black Sheep.* An instant bestseller, the autobiography is still in print after more than four decades. Moreover, in the 1970s Boyington sold the book's movie rights and became a technical adviser to the short-lived, and much embellished, television series about his experience with the Black Sheep Squadron. Boyington died in California on 11 January 1988 and was buried in Arlington National Cemetery.

Jeffrey J. Matthews

See also

American Volunteer Group; Chennault, Claire L.; U.S. Marine Corps Aviation

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Braun, Wernher von (1912–1977)

A powerful influence on the fledgling U.S. space program. Wernher von Braun was inspired by Hermann Oberth's writings, which attracted him to one of Germany's many amateur rocket clubs. Impressed by von Braun's enthusiastic knowledge, Walter Dornberger, an artillery officer, asked the young engineer to help establish a national rocket program.

In 1937, von Braun's team moved to Peenemünde on the Baltic Sea, where it created the first modern rocket, the A-4 (V-2). Two years after its first launch on 3 October 1942, the V-2 began attacks on Europe. In 1945, the Gestapo arrested von Braun for talking about future spacecraft but released him. Following his release and realizing that the war was lost, von Braun gathered 127 scientists and departed Peenemünde to search for the U.S. Army.

The Americans captured von Braun and sent him and his team under Operation PAPERCLIP to launch captured V-2s for the new U.S. rocket program in White Sands, New Mexico. In 1950, von Braun's group moved to Huntsville, Alabama, to work in the U.S. Army's Redstone missile plant and designed the medium-range missiles Redstone, Jupiter, and Jupiter-C. After a U.S. satellite launch attempt failed, von Braun's team used a Jupiter-C to launch America's first satellite, *Explorer 1,* on 31 January 1958.

In 1960, the National Aeronautics and Space Administration (NASA) took over the Redstone plant and von Braun's group that subsequently led the Apollo program. To support Apollo the von Braun team designed, tested, and flew the Saturn I, Saturn I-B, and the largest spacecraft ever built, the 364-foot Saturn V. The Saturn V launched 27 men to the moon and allowed 12 Americans to walk on its surface. After Apollo, von Braun worked for NASA HQ and then transferred to Fairchild Industries until his untimely death from cancer in 1977.

John F. Graham

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Brazil, Air Operations in World War II

In 1941, as airpower's importance was displayed in the European war, Brazil's army and navy air units were combined into the Brazilian Air Force. Meanwhile, the government steadily aligned itself with the Allies, despite large German, Italian, and Japanese immigrant populations. This led to hundreds of aircraft being provided by the United States via Lend-Lease. Initially, Fairchild PT-19 and Vultee BT-15 trainers were of the most importance. But later, fighters and other combat aircraft were provided.

Brazil's geographical position gave it a special importance. The so-called Brazilian Bulge—the northeast region of the country—faced West Africa across the South Atlantic. This was a crucial supply route to the Middle East and the Soviet Union. Money from Washington constructed land bases in northern Brazil, where mostly seaplanes had flown previously.

Submarine warfare became intense in 1942. Torpedoed ships pushed Brazil to declare war on Germany and Italy in August, after months of increasing conflict. U.S. antisubmarine patrols from Brazil were increasingly supplemented and finally replaced by the Brazilian Air Force. U-199 was sunk by a Brazilian Consolidated PBY flying boat in July 1943, after initial damage by a U.S. Martin PBM Mariner. Brazilian Lockheed Venturas patrolled by mid-1944.

Meanwhile, the Brazilian Air Force was training in the United States on Curtiss P-40s before switching to Republic P-47 Thunderbolts. The 1st Fighter Unit was trained in bomber escort, but duties in Italy from 31 October 1944 focused on attacking ground targets with 500-pound bombs. On 22 April 1945, the peak day, it flew 11 missions involving 44 flights (with 22 pilots). The unit destroyed 97 motorized and 35 animal-drawn vehicles, 14 buildings, several bridges, three artillery positions, and more. Brazil participated in World War II more than any other Latin American nation. Its strategic location produced early involvement. Ultimately, the Brazilian Expeditionary Force provided ground troops in Italy (1944–1945), supported by Brazilian Piper Cub L-4 spotter aircraft. The Brazilian Air Force achieved impressive statistics in destroying German army targets.

Brazilian airpower developed greatly during the war years. Five pilots were killed by antiaircraft fire and three more in accidents during just over six months of operations. Despite the losses, Brazilian airpower was much enhanced by the war-time experience. Even though governments after 1945 were less focused on aviation than was President Getulio Vargas (in power from 1930 to 1945), Brazil had an improved infrastructure and an experienced group of airmen. This experience paved the way for the growth of aviation in Brazil, which today has a thriving indigenous aircraft industry.

Gary Kuhn

Brazilian Aircraft Industry

The Brazilian firm Embraer (Empresa Brasileira de Aeronautica) has become a significant aircraft manufacturer internationally. It is a leading exporter of regional jetliners (earlier turboprop), and its rivalry with Canada's Bombardier firm parallels the Airbus-versus-Boeing struggle to sell larger airliners. Meanwhile, Embraer continues to produce military aircraft suited to national needs, also with some export success. It is a successful culmination of efforts by Brazilian governments to establish an indigenous aviation industry.

In the 1920s, Rio de Janeiro shipbuilder Henrique Lage and army officer A. G. Muniz began efforts to design and build aircraft. Subsequently, a few HL and Muniz light aircraft were produced. After 1930, the government of President Getulio Vargas was particularly interested in aviation, given Brazil's size, limited infrastructure, and need for development. The naval factory at Galeao, in Rio de Janeiro, became the government's factory.

Airpower came into sharper focus as World War II approached. Galeao constructed 40 Focke-Wulf Fw 44 trainers, 26 twin-engine Focke-Wulf Fw 58s, and 220 Fairchild PT-19 trainers.

As foreign sources of aircraft shifted to war production, Brazilian factories tried to fill the void. A plan to produce the North American T-6 Texan, the most complex aircraft yet attempted, suffered many delays, although 81 were ultimately built locally.

The industrial state of São Paulo began to eclipse Rio as the government launched the National Campaign of Aviation, which would provide planes to aero clubs. The great success of the 1940s was the CAP-4 Paulistinha (the name indicating its São Paulo origin). This Piper Cub look-alike reached one-a-day production by 1943, with nearly 800 built during the decade. A few years later, another 300 updated Neiva P.56 Paulistinhas would be constructed. These aircraft flew for many years in Brazil.

São Jose dos Campos, in São Paulo state, emerged in the 1960s as Brazil's center for airpower. The air force–funded Centro Tecnico Aerospacial (CTA) conducted research. Two factories constructed all-metal military trainers.

These plants would become Embraer and its Neiva subsidiary (for light civil aircraft production). The breakthrough airplane, begun at CTA and built at Embraer, was the EMB-110 Bandeirante, a twin-engine turboprop airliner for regional airline use. Meanwhile, the celebrated Ozires Silva began his managerial career as the company began to expand.

In addition to many air force and national feeder-liner Bandeirantes, export sales were good. Also in the small airliner niche was the subsequent EMB-120 Brasilia. Eventually, the regional jets EMB-145 and EMB-135 would be developed. Military types of moderate sophistication also succeeded. The Tucano turboprop trainer/light attack creation of the 1980s was adopted locally and abroad. Collaboration with Aermacchi led to the MB-326 (AT-26 in Brazil) fighter-bomber in the 1970s. The AMX's further development in the 1990s saw Italian versions employed with success in the Balkans.

Brazil's aircraft industry was shaped by the government to focus on national needs. A variety of touring and agricultural aircraft is produced for the domestic market; airliner exports improve the trade balance; and the majority of military aircraft are nationally produced. The latest projection of Brazilian airpower is Embraer's manufacture of airplanes dedicated to electronic detection and combat patrol of the vast Amazon region.

Gary Kuhn

Breda Aircraft

Founded in 1886 in Italy by Ernesto Breda (1852–1918) as a locomotive factory. The firm formed a dedicated aircraft unit (Section 5) in 1917 upon receiving an order for 600 Caproni Ca.5 bombers. Breda completed only two aircraft before the Armistice but thereafter remained involved in aviation, starting a flying school on the airfield adjacent to its Sesto San Giovanni works. For the next 15 years, Breda concentrated on touring monoplanes and biplane trainers (including the Ba.19 used by the first Italian acrobatic teams and the Ba.25 standard trainer), occasionally experimenting with multiengine bombers like the CC.20 and Ba.32.

In 1935, Breda acquired Officine Ferroviarie Meridionali and Industrie Aeronautiche Romeo, both located in Naples, and merged them into Industrie Meccaniche e Aeronautiche Meridionali (IMAM, later IMM). Its main products were the Ro.37 army cooperation two-seater (1934), Ro.43 observation floatplane (1936), and Ro.41 advanced trainer (1934).

Turning to all-metal technology, Breda introduced the Ba.64 and Ba.65 attack monoplanes (1935) and the Ba.88 twin-engine heavy fighter (1936). None met expectations, forcing Breda to build Macchi C.200 and C.202 fighters under license. To overcome this crisis, in 1942 Breda engaged

Filippo Zappata (1894–1994) and prepared to produce the Cant Z.1018 twin-engine bomber and its BZ.301–304 derivatives, but on 30 April 1944 the factory was virtually wiped out by U.S. bombers.

The postwar BZ.308 four-engine airliner (1948) and the BP.471 general-purpose twin (1950) were technically successful, but the lack of orders forced Breda to close Section 5. Already in a deep financial crisis, in 1952 Breda sold IMM to the state (it became known as Aerfer and would eventually merge into Aeritalia) but was itself taken over by the state conglomerate EFIM in 1962. It briefly returned to aviation in 1971, producing Hughes Model 500 helicopters through the BredaNardi joint venture, soon absorbed by Agusta.

Gregory Alegi

See also

Aermacchi; Cant Aircraft; Italian Aircraft Development

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Breguet Aircraft

Louis and Jacques Breguet, scions of the famous clock- and watch-making family, were interested in aviation at an early age. On 19 September 1907, they, in cooperation with Professor Charles Richet, created the first helicopter capable of lifting a man. A second model, the Breguet-Richet II, followed, but stability problems proved to be intractable and further development was abandoned.

Always innovative, the first Breguet aircraft flew in 1909 and featured the use of structural steel tubing. The Société des Avions Louis Breguet was formed in 1911 and continued to operate until 1971.

The Breguet 14 was one of the most successful aircraft of World War I and became the foundation for many later Breguet aircraft. The Breguet 14 was operated as both reconnaissance plane and bomber, and some 5,300 were built during the war. They were used in several theaters and, after the conflict, were widely exported to a dozen air forces around the world. Powered by a 300-hp Renault engine, the Model 14 had a top speed of 114 mph and could carry 88 pounds of bombs.

The next great Breguet success was the Model 19, which was also extensively exported and became engaged in many minor conflicts around the globe, with 3,280 being built. Specially modified versions were used to set many long-distance records.

Between the two world wars Breguet blossomed, building airliners, bombers, and flying boats, most of which were strikingly unattractive aesthetically. Breguet adopted a more modern, streamlined formula in its most successful series of aircraft, which began with the Bre.690 and entered production as the Bre.693. The Bre.693 served France during the German invasion in May and June 1940, suffering heavy losses.

Breguet was impressed by the Germans to build aircraft for the Luftwaffe during the occupation of France. After the war it built the large and rather rotund Breguet 761 in small numbers. Its principal postwar success came with the Breguet 1050 "Alize," a turboprop attack plane that served with the French navy for many years, and the Atlantic patrol aircraft.

The French government passed control of the company to Dassault in 1971, forming Avions Marcel Dassault/Breguet Aviation. Corporate identity was finally lost in 1990, when the name was changed to Dassault Aviation.

Walter J. Boyne

See also

Dassault, Marcel

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Bristol Aircraft (Early Years, World War I)

British and Colonial Aircraft Company Ltd. was well established prior to World War I, having produced a series of monoplanes and biplanes for sporting purposes. The most notable was the Boxkite and a sleek little biplane just appearing on the scene in the summer of 1914, the Scout.

In the next year, the Bristol Scout became one of the aircraft that had to deal with the Fokker monoplane. The problem was how to mount a machine gun given the lack of a British interrupter gear, which permitted firing through the propeller arc. One innovative solution mounted a Lewis gun at a 45-degree angle, the butt end being at the cockpit so the ammunition drum could be changed, the muzzle just clearing the spinning propeller. Effective use of a gun affixed in this manner required the greatest skill. One such gifted pilot was Captain Lanoe George Hawker, the first British ace of the war. In the course of a single patrol in a Bristol Scout with an oblique-mounted Lewis, Hawker brought down three German aircraft, the first triple victory of the war. For this singular feat he received the highest British decoration, the Victoria Cross.

Bristol also produced an outstanding monoplane fighter, the M.1, which fell victim to a ban on monoplanes imposed following a few structural failures prior to the war.

But it was the F.2, the famous Bristol Fighter, that etched the name of the company in historical stone. The Bristol Fighter ("Biff" or "Brisfit") was originally conceived as a two-seat general reconnaissance aircraft intended to replace the aging Royal Aircraft Factory BE.2 observer. By the time it appeared, however, it was realized that its compact size (from a distance it had the appearance of a large single-seater), good turn of speed and handling characteristics, and respectable firepower would be better utilized in fighter duties. Crews had some initial difficulties adjusting their thinking to this changed role and continued, for a time, to fly the Bristol as a conventional two-seater.

Appearing at the front in April 1917 in No. 48 Squadron, the Bristol initially garnered unfavorable reviews. This stemmed from a disastrous encounter between No. 48 Squadron and Jasta 11. The inexperienced British crew, led by William Leefe Robinson, who had received the Victoria Cross for shooting down the airship SL11 the previous year, did not appreciate the Bristol's ability as a fighter. Instead of attacking with the front gun, they adopted the traditional tactic of trying to position the rear gunner for a shot. The crack pilots of Jasta 11, led by Manfred von Richthofen, punished them, bringing down four of the six.

Despite this failure, the Bristol went on to great success, developing a reputation as the best British two-seater of the war. It continued in RAF service, though in sometimes highly altered form, well into the 1930s.

James Streckfuss

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Bristol Aircraft (Post–World War I)

The British firm Bristol developed a strong line of aircraft engines after World War I that were used as the preferred type in its aircraft designs. Blessed by good management and such excellent leaders as Roy Fedden, Frank Barnwell, and Stanley Uwins, Bristol built a series of aircraft during the interwar years, the most important of which were the Bulldog fighter and the Blenheim bomber. The Bulldog was a fixed-gear, open-cockpit biplane typical of the period, and the Blenheim was a modern twin-engine aircraft with retractable landing gear and enclosed cockpit. Although not terribly successful as a bomber, the Blenheim served ably as a night-fighter and antisubmarine warfare (ASW) aircraft.

Two developments of the Blenheim line, the Beaufort and the Beaufighter, were far more successful. The Beaufighter was adapted to many roles, including close air support, night-fighting, and antishipping strikes.

After World War II, Bristol built the huge Brabazon, a 230-foot-wingspan giant that was perhaps ahead of its time; only two were built. This was followed by the prosaic Freighter, a twin-engine, fixed-gear passenger/cargo plane. About 214 were built, and they served ably around the world for many years.

Bristol's final success was the beautiful four-engine Britannia, which served well as an airliner in several countries. Modified, it was successful both as a swing-tail freighter and as an ASW aircraft.

Bristol also developed a helicopter business, using Raoul Hafner's designs initially, but these were built in relatively small numbers. Bristol was absorbed into the British Aircraft Corporation in February 1960; Bristol Aero-Engines became first part of Bristol-Siddeley Engines and then was absorbed by Rolls-Royce.

Walter J. Boyne

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Bristol Beaufighter

Because of a lack of night-fighting capability of the British Royal Air Force in 1938, a private venture of the Bristol Aeroplane Company developed and delivered the world's first true night-fighter to combine all the equipment necessary—radio, radar, armament, and performance—in only eight months, the Beaufighter.

The "Beau" was developed from the Beaufort general reconnaissance and torpedo-bomber, using its major components, including wings, tail assembly, and undercarriage. Only the main fuselage and the engine mountings were entirely new components. The first prototype with the normal crew size of two, a pilot and gunner, flew on 17 July 1939. A pair of Hercules 1,500-hp radial engines powered the aircraft, which was armed with a battery of four 20mm Hispano cannons in the fuselage nose, six 0.303-inch machine guns in the wings, and one 0.303-inch Vickers K or Browning gun in the dorsal position. In later versions, one 18-inch torpedo, mounted externally under the fuselage, or eight rocket projectiles could be carried as alternative to wing guns. By 21 September 1945, a total of 5,562 aircraft had been produced in the United Kingdom, having been flown by the air forces of Great Britain, Australia, New Zealand, and the United States.

From Europe to the Middle East and the Far East, all Beaufighters served with distinction, earning the title

"Whispering Death" from Japanese pilots, a remark referring to the speed at which one could suddenly appear with little or no warning.

Guy T. Noffsinger Jr.

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Bristol, Delbert L. (1918–1980)

Colonel in the U.S. service. Born in Kansas City, Missouri, Bristol enlisted as a private in the Missouri National Guard in 1936. In 1939, he received a direct commission as a second lieutenant in the Field Artillery Reserve. Called to active duty early in 1941, he served at Fort Sill, Oklahoma, where 1st Lieutenant Robert R. Williams convinced him to obtain his civilian pilot's license. When Lieutenant Colonel William W. Ford organized a detachment to test the concept of organic air in the Field Artillery, he chose Bristol to be his adjutant.

Following the creation of the Field Artillery aviation program, Bristol accompanied the first serial of pilots and mechanics dispatched to the United Kingdom. When they were diverted to Northern Ireland as infantry replacements, Bristol talked his way into II Corps HQ in London and convinced the corps staff to rectify this error. He subsequently became the artillery air officer on the staff of the chief of artillery II Corps in North Africa and revitalized the program when it faced early termination. Subsequently appointed artillery air officer of the U.S. First Army, he developed plans to move liaison aircraft to the continent during the Normandy invasion and, during the Battle of the Bulge, personally vectored U.S. Army Air Forces fighter-bombers onto German armored columns.

In the 1940s and 1950s, he operated effectively behind the scenes to enlarge the scope and mission of U.S. Army aviation. He held assignments of increasing importance, culminating as acting director of Army Aviation in 1966. He publicly opposed the Johnson-McConnell Agreement, which transferred the Army's largest fixed-wing air transports to the Air Force and as a result was banished to Aviation Systems Command in St. Louis, Missouri. He retired in 1971.

Bristol was perhaps the key officer in keeping the Field Artillery aviation program viable during its initial shakedown in combat during World War II. He continued to be very influential after the conflict. Always a strong advocate of fixed-wing aircraft, he effectively precluded any chance of his further promotion by standing on principal.

Edgar F. Raines Jr.

Britain, Battle of (1940)

In June 1940, Adolf Hitler stood at a pinnacle of success. France lay vanquished and the British had been driven from the continent. Leading a war machine organized and equipped for swift victories in short conflicts, Hitler hoped Great Britain would quickly come to terms. When the British, inspired by Prime Minister Winston Churchill, refused to yield, Nazi Germany was compelled to improvise an invasion effort across the English Channel. The success of such a venture demanded control of the air over southeastern England. Thus the stage was set for a decisive air battle between the Luftwaffe and the Royal Air Force.

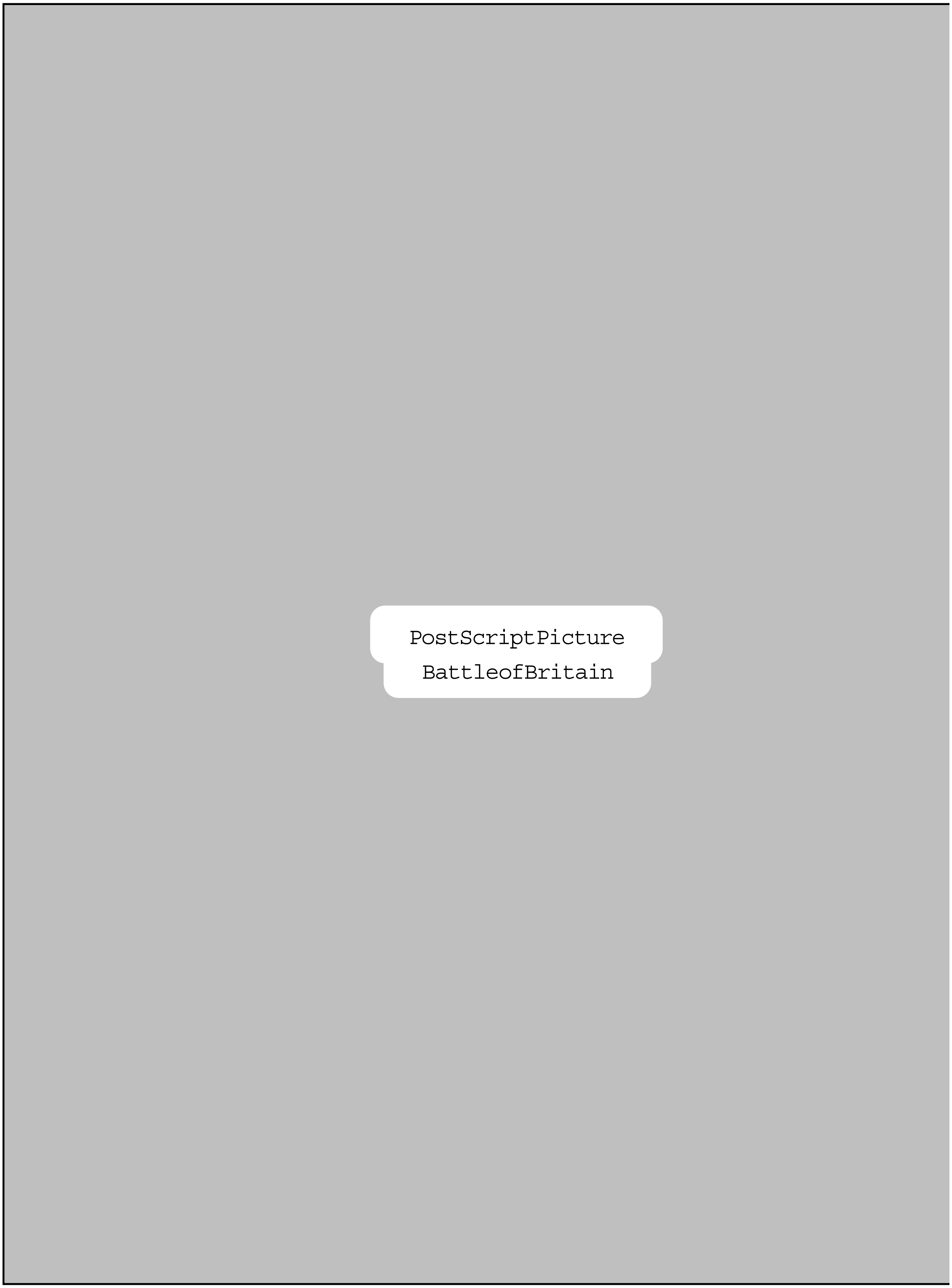
The Luftwaffe was a tactical air force dedicated to attacking enemy rail centers, roadways, and air bases, clearing the path for Germany's fast-moving armored forces. The crews of the Junkers Ju 87B "Stuka" single-engine dive-bomber were the elite of the Luftwaffe. Although an accurate bomber, the Stuka proved easy prey for enemy fighters. The Heinkel 111H, Dornier 17Z, and Junkers 88A twin-engine bombers were rugged but slow and also deficient in defensive armament.

In the Messerschmitt Bf 109E the Luftwaffe fielded an excellent single-engine fighter. It was well-armed, fast, and could outclimb and outdive its English adversaries. But visibility from the cockpit was poor, and its operating range was limited.

The Germans possessed a long-range fighter, the twin-engine Messerschmitt Bf 110C. It was fast, heavily armed, and handled well but could not match the acceleration and maneuverability of its RAF opponents.

Despite German shortcomings, the head of the Luftwaffe, Hermann Goering, was determined to win a decisive victory through bombing alone. Goering shared the widely held belief at that time that the bomber would always get through, that is, bomber forces would penetrate the enemy's defenses. In serviceable aircraft the Germans amassed 998 twin-engine bombers, 248 Stukas, 805 Bf 109 fighters, and 224 Bf 110 machines.

However, Britain in the late 1930s had developed the first defensive system against air attack incorporating the new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radio direction and ranging detection system (radar). Contrary to dominant thinking, Thomas Inskip, minister for the coordination of British defense, in 1937 argued that radar and fast monoplane fighters offered effective defense against bombers. Noting that Germany clearly wanted quick triumphs, Inskip asserted that the British did not need to decisively defeat Germany but rather resist German attack and survive. Britain could thus force Germany into a long war for which the Nazi regime was not prepared.

Air Marshal Hugh Dowding, as the Air Council member for Research and Development, worked closely with the scientist Robert Watson Watt in the practical application of radar for defensive purposes. Beginning in 1936 Dowding, as commander of RAF Fighter Command, developed the integrated air defense system vital to England's survival.

When approaching enemy aircraft were detected by the radar towers along the coast, their flight path over land was tracked by the Ground Observer Corps, a force of indispensable volunteers. These reports were phoned to Fighter Command headquarters and evaluated. Information so assessed was sent on to the Sector Operations centers threatened. The sector controller ordered squadrons into the air and guided them into action by radio. At all levels, the plotting tables showing the positions of warplanes were operated by the Women's Auxiliary Air Force.

On 9 August 1940, fighters available for combat in Fighter Command included 568 Hawker Hurricanes and 328 Supermarine Spitfires. Although the Hurricane 1 could not match the performance of the Bf 109E, it was easy to fly, could absorb much damage, and was quick to repair. The Spitfire was based upon an advanced elliptical wing design by Reginald Mitchell that featured maximum area, low wing loading, great strength, and as thin an airfoil as possible. The Spitfire proved a good match against the Bf 109E. Visibility in the Spitfire was excellent. Both fighters were armed with eight .303-caliber machine guns and featured armor protection for the pilot and a bulletproof windscreen.

Both British fighters benefited from 100-octane fuel. German aircraft used synthetic gasoline of 87–89 octane. Use of 100-octane fuel in the English Merlin engines raised horsepower from 1,030 to 1,310 (the Daimler Benz engine in the Bf 109E was rated at 1,175 hp). Consequently, the Hurricane was able to hold its own and the Spitfire gained an edge.

Tactically, the English began with a tight vee of three fighters, an unwieldy and obsolete formation. As the battle progressed, the British emulated the flexible German formation of two fighters—leader and wing man—developed in the course of the Spanish civil war.

Southeastern England, including London, was the main arena of the Battle of Britain. This was the area closest to the continent and within the 90-minute endurance of the 109E. Fighter Command's No. 11 Group bore the brunt of the fighting, aided by No. 12 Group adjacent to the north.

From 10 July to 11 August, Britons suffered German attacks on Channel convoys and fighter sweeps over southeastern England. Dowding limited the RAF response to such provocations. In August, the Germans unleashed an all-out assault on radar installations and air bases. Such raids began 12 August and were accompanied by nighttime bomber attacks on 13 August, utilizing electronic guidance beams, and falling upon Liverpool, Birmingham, Aberdeen, and Belfast. On 15 August, daylight blows fell upon England from occupied Norway and Denmark, but these German bombers and their Bf 110 escorts were intercepted by No. 13 Group, which inflicted nearly 20 percent losses on the attackers. "Black Thursday," as the Germans termed it, proved that daylight bombing could only be undertaken with Bf 109E fighter escort.

On August 19, Goering withdrew the Stuka dive-bombers from the battle. Some Bf 110 units were disbanded, and in less than three weeks 40 percent of their strength had been lost. However, German attacks on air bases intensified from 29 August through 6 September. Airbases in No. 11 Group were repeatedly hit. From past campaigns, German bomber crews were experienced in low-level operations against airfields.

Dowding did not dare withdraw from southeastern England. Such a move would open the door to invasion. Flying from English airstrips would be a great advantage for 109Es.

A high level of fighter production ensured warplane replacements for Fighter Command. But Dowding lost 25 percent of his pilots in a two-week period. Some new replacements had only 10 hours' flight time in a fighter. By early September, six out of seven sector airbases and stations were severely damaged. But time was running out for the Germans as well. The date for invading the British mainland had been repeatedly postponed. Now the storms of autumn loomed.

Convinced that Fighter Command had been largely destroyed, the Germans sought to bring the remaining English fighters to battle and eliminate them quickly. An attack on London would surely bring those fighters into action. On 7 September, 900 warplanes set forth to bomb London. The Germans were elated when mass raids by day and night churned London into a sea of flames. With London as the target, however, Fighter Command could rebuild its airbases, and pilots gained much-needed relief from constant pressure. Replacements could be given essential training.

During another massive daylight attack on 15 September, Dowding committed 300 British fighters into battle. The Germans had been repeatedly assured that only 50 English fighters remained. German elation now turned to bitter disillusionment. On 17 September Hitler postponed invasion plans indefinitely. A long ordeal, nighttime bombing, and later V-1 and V-2 attacks lay ahead for London and other English cities. But the threat of Nazi invasion never materialized again.

The myth of German invincibility had been shattered. Germany would be compelled to wage a long war. Britain would become the base where immense Allied forces would be amassed, the springboard from which Europe would be liberated and Nazi Germany defeated.

Sherwood S. Cordier

See also

Beaverbrook, Lord; Dowding, Hugh C.T.; Goering, Hermann; Radar; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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British Aerospace

The culmination of a series of aviation-industry mergers after the Aircraft and Shipbuilding Industries Act was passed in 1977 by the British government. Thus, on 29 April 1977 the British Aircraft Corporation, Hawker-Siddeley Aviation, Hawker-Siddeley Dynamics, and Scottish Aviation combined under one banner: British Aerospace (now BAe Systems).

The new organization inherited factories and installations at Brough, Chester, Filton, Kingston, Hatfield, Preston, Warton, Weybridge, and Woodford. Partial privatization of the conglomerate saw the final disappearance of the individual company identities; thereafter all products were identified by their new owner's name. Complete privatization followed in May 1985.

One of the consequences of this was a rationalization of the company's facilities; the Weybridge, Kingston, and Hatfield factories were closed and their products transferred elsewhere. Aircraft produced or supported by British Aerospace include the Harrier, Hawk, Nimrod (now being rebuilt to the MRA.4 standard), Tornado, and the Eurofighter Tornado.

Kev Darling

British Aerospace Harrier

The only vertical/short takeoff and landing aircraft to enter regular squadron service in any numbers. The Harrier began life as a development of the earlier P.1127 and Kestrel experimental and development aircraft.

Developed by the original parent company, Hawker-Siddeley, the Kestrel evolved into the Harrier, which was intended for use in the strike, attack, and reconnaissance role close to the front line of battle. To enable the aircraft to function effectively, full use is made of its V/STOL capability, which allows battlefield commanders almost instant access to air support.

It was on this premise that the first Harrier GR.1 aircraft were delivered to RAF No. 1 Squadron in December 1967, the first production version having made its maiden flight the previous August. A total of 131 Harriers were finally delivered, including 90 GR.1/As plus 17 trainer versions; 24 advanced GR.3s incorporated a laser-ranging and marked-target seeker in the nose, among other improvements. The surviving Harrier GR.1s were also converted to this standard.

It was this adaptability that first brought the Harrier in its earlier GR.1 form to the attention of the United States Marine Corps. Designated the AV-8A, the USMC aircraft underwent very few changes to suit it for Marine service.

Another version of the first-generation Harrier was built: the Sea Harrier developed for the Royal Navy. To enable the aircraft to perform its duties more efficiently, the nose was redesigned to accommodate the pilot in a higher seating position. This allowed fitting of a nose radar suited for the role of fleet defense.

Both British versions of the Harriers took part in the Falkland Islands War. The former attacked ground targets prior to and after the landings while the navy jets shot down Argentine aircraft in defense of the fleet.

Both early variants of the Harrier have now left the service of the RAF and the Fleet Air Arm, although the latter version has been rebuilt into the far more capable FRS.2. A similar fate befell the aircraft of the USMC, although not before some had been upgraded to AV-8C standard. Redundant aircraft from the USMC were later passed on to the navies of Spain and Thailand.

The second phase of Harrier development involved a joint venture between British Aerospace and McDonnell Douglas (later Boeing MDD). Essentially a total redesign, the new aircraft featured composite construction throughout. One of the major components is an enlarged wing capable of an increased weapons load on extra pylons. The fuselage also underwent some changes, especially in the nose area. As with the Sea Harrier, increased cockpit height allowed an array of sensors to be mounted in the nose; a revamped canopy increased the pilots vision area.

This new variant has been delivered to the USMC, the RAF, and the Italian navy. In common with the earlier-generation aircraft, batches of trainers were delivered to the operators of the single-seaters. Of the three aircraft types dedicated to V/STOL development worldwide, only the Harrier has became a success.

Kev Darling

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British Commonwealth Air Training Plan (BCATP)

A major contributor to the Allies' victory in the air war against the Axis powers during World War II.

The BCATP originated in the prewar strategic requirements of the Royal Air Force and in the long-time military, political, and cultural ties between Canada and Great Britain. During World War I, Canada served as a training centre for the Royal Flying Corps and RAF, and the RAF believed—mistakenly, as it turned out—that it could renew that arrangement during World War II. For William Lyon Mackenzie King, then Canadian prime minister, the issue was one of sovereignty: He refused outright to permit any of the training conducted in Canada to come under British control. On 17 December 1939, after protracted negotiations, the BCATP between Canada, Great Britain, Australia, and New Zealand was finally signed.

The BCATP was also dictated by geography and industrial mobilization as well as by demography. The plan's large-scale training commitments required numerous airfields and clear skies free from the threat of enemy air activity. Equally important, training had to take place close to the most important operational theater, Western Europe. Moreover, these training centers had to be located near an industrial base with potential expansion for airframes and engines for training aircraft. Canada was ideally suited in this regard. Finally, Canada, unlike the other dominions, had a larger population from which to recruit the aircrews.

The BCATP was part of the wider Empire Air Training Scheme designed to produce large numbers of trained aircrews. Canada, initially the largest contributor outside of Britain, adopted the BCATP designation. The British and the other partners, however, usually employed the imperial terminology until the summer of 1942. According to BCATP Article 15, the so-called Ottawa Agreement, dominion aircrews were to be identified with their country of origin by the creation within the RAF of distinctive dominion components. That way, dominion personnel would not be broken up into RAF squadrons, thereby maintaining effective control of national forces. The plan was to run until 31 March 1943 and was supposed to train some 90,000 personnel by the end of the three-year program. The BCATP exceeded all expectations.

The Royal Canadian Air Force (RCAF) controlled the program with assistance from the RAF; by 1943, the BCATP training centers were manned by 104,000 ground personnel operating approximately 10,000 aircraft.

More than 50 air-training schools were created in Canada alone between April 1940 and December 1941; by 1943 97 schools and 184 auxiliary establishments had been put in place. Nearly 40,000 trainees—more than half as many again as originally planned—passed through these schools during the same period; Canada contributed more than 80 percent of all students until May 1942. Some 33 training establishments were created in Australia, training approximately 9,600 personnel before they headed to Canada for advanced training; some 7,000 New Zealanders graduated from the training schools. Another 15,000 Australians received all of their flying training in Canada before being dispatched to Britain.

By war's end, the BCATP had produced 131,553 aircrewmen, of which 72,835 (51 percent overall) were Canadians. Moreover, of all the Commonwealth men trained during the war, fully 45 percent received some or all of their training in Canada. The costs of the program had risen significantly as well. Over the course of the program (1939–1945), the BCATP cost approximately $2 billion; Canada paid 72 percent. Canada was indeed, as U.S. President Franklin Roosevelt proclaimed, the "aerodrome of democracy."

Shawn Cafferky

See also

Canadian Air Force; Royal Australian Air Force; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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British Pacific Fleet

The British Pacific Fleet (BPF) formed on 22 November 1944 around four fleet carriers: *Indomitable, Victorious, Indefatigable,* and *Illustrious* (replaced 14 April 1945 by *Formidable*). After initially operating under the aegis of the East Indies Fleet, it left Trincomalee (Sri Lanka) on 16 January 1945 to join the U.S. Pacific Fleet at Okinawa.

En route, BPF launched two strikes against Sumatran oil refineries in the Palembang area. For the loss of 23 aircraft from all causes, BPF cut Japanese aviation gasoline output by 65 percent. This strike series was arguably BPF's greatest single contribution to the eventual victory over Japan.

BPF's mission assignment at Okinawa was to keep the six airfields in the Sakishima Gunto out of action in order to suppress Japanese air defenses against the invasion force and prevent aerial reinforcement of Okinawa itself. The carriers, between 26 March and 25 May, established a routine of two- to three-day strike serials followed by similar replenishment periods. Since the Japanese used crushed coral, in limitless supply, to construct these runways, bomb damage usually was repaired overnight. Although its unremitting efforts appeared fruitless, when less-capable U.S. escort carriers replaced BPF while it replenished, greater air activity against the invasion fleet demonstrated the British carriers' efficacy.

While BPF operated off Sakishima, kamikazes hit all the carriers (and *Formidable* and *Victorious* twice). Their armored flight decks resoundingly demonstrated their value—all were fully operational within a few hours, and only 44 ships' crewmen lost their lives.

Implacable replaced *Indomitable* as BPF rejoined the U.S. Pacific Fleet on 17 July for final attacks on Japan's home islands. Integrated into Third Fleet as Task Force 37, its aircraft launched a relentless attack on Japan's military and mercantile shipping, land transportation systems, industry, and remaining air assets. Operations continued until 15 August, although most of BPF had withdrawn by then to replenish, leaving only *Indefatigable* on the line.

Fleet Air Arm aviators earned their second Victoria Cross of the war, posthumously awarded on 9 August to Lieutenant Robert Hampton Gray for his courageous leadership during an attack that sank the escort *Amakusa.*

BPF carriers proved their toughness and efficiency during the Okinawa and home islands campaigns, sustaining high-intensity strike missions against airfields, shipping, and rail and road systems while maintaining effective fleet defense and surviving attacks that crippled their contemporaries in other navies.

Paul E. Fontenoy

See also

Fleet Air Arm; Okinawa; Task Force 38/58; Vian, Philip L.

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Bulge, Battle of the (1944–1945)

World War II German surprise attack and Allied defense and counterattack in the Ardennes region of southwestern Belgium and northern Luxembourg from 16 December 1944 to 16 January 1945. The battle caused many problems for Allied commanders. The German planners scheduled the attack to take place during poor weather, which would limit the effects of Allied tactical airpower. Additionally, the German Luftwaffe concentrated significant air resources in an attempt to provide direct support to the offensive and to counter Allied air capabilities.

Although fog and snow limited air operations during much of the fighting, Allied airpower made significant contributions to the outcome of the battle. Even during bad weather, Allied pilots strove to provide reconnaissance support and to attack German targets through breaks in the weather.

When relatively clear conditions occurred, such as between 23 and 28 December and on 1, 2, and 5 January, the Allied air forces conducted extensive attacks on German forces and supply lines. The USAAF Ninth Air Force and the RAF Second Tactical Air Force provided direct support to Allied ground forces, conducted armed reconnaissance missions, waged an aggressive interdiction campaign, and defended against Luftwaffe operations. Senior Allied commanders also shifted elements of RAF Bomber Command and USAAF Eighth Air Force heavy bomber forces from the strategic bombing offensive against Germany to interdiction targets and airfield attacks. Both sides conducted airdrops—Luftwaffe air transport units supported the initial offensive with an airborne assault and with limited resupply drops, and USAAF air transport units provided support to the isolated American forces at Bastogne.

On 1 January 1945, the Luftwaffe conducted its last significant offensive operation of the war with a counter–air strike against 17 Allied airfields in Belgium, Holland, and France. Although Operation BODDENPLATTE (BASE PLATE) inflicted significant damage on some airfields, the Luftwaffe suffered heavy losses of aircraft and pilots that it could not afford at this point in the war. Although the Battle of the Bulge is normally remembered as exclusively a ground operation, airpower made important contributions to the ultimate success of the Allied forces.

Jerome V. Martin

See also

German Air Force (Luftwaffe); World War II Aviation

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Bureau of Aircraft Production (BAP)

Immediately upon entering World War I, some optimists in the United States began talking about huge production programs that would "darken the skies of Europe with American aircraft." A year later the promised fleet had not arrived, though not for lack of effort. It was simply that no one in the United States, when the boast was made, had a real understanding of how difficult a task lay ahead.

In May 1918, in an attempt to solve the problem, two new agencies were created: the Division of Military Aeronautics (DMA), which dealt with personnel, and the Bureau of Aircraft Production, which handled equipment. John Ryan, the former president of Ananconda Copper and then chair of the Aircraft Board, a civilian agency, was appointed to head up the BAP. Both the BAP and the DMA became part of the Air Service. Despite this common assignment, a problem developed due to a lack of coordination between the two agencies. This was solved later in the summer with the promotion of Ryan to the post of director of the Air Service at a second assistant secretary of war level. The BAP had responsibility for deciding which aircraft the United States would build.

James Streckfuss

See also

U.S. Aircraft Development and Production (World War I)

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Bureau of Naval Aeronautics (BNA)

Created by the U.S. Congress in 1921 to advise the Secretary of the Navy, the Department of the Navy, and the Chief of Naval Operations on naval aviation. The BNA consolidated and centralized all administrative, logistical, and technological functions pertaining to aircraft under one administrative jurisdiction.

Prior to World War I, the Bureaus of Construction and Repair, Steam Engineering, and Navigation shared responsibility for naval aeronautics. In 1913, Secretary of the Navy Josephus Daniels appointed a board of officers led by Captain Washington I. Chambers, the officer in charge of aviation, to draw up a comprehensive plan for a naval aeronautics service. The subsequent Chambers Report recommended, among other things, the formation of a central aviation office to oversee naval aviation. In response, Secretary Daniels created the Office of Naval Aeronautics within the Division of Operations. This early effort at coordination proved disappointing; authority over aeronautics remained dispersed among the bureaus, with the Bureau of Construction and Repair leading the way.

Following the war, General William "Billy" Mitchell and other proponents of airpower urged Congress to create a central bureau to alleviate this administrative confusion and promote naval aviation. Congress consequently established the Bureau of Naval Aeronautics, responsible for matters pertaining to designing, building, and repairing Navy and Marine Corps aircraft.

Under Bureau Chief Admiral William A. Moffett, the BNA promoted use of airpower, working to incorporate aircraft into fleet operations and strategic planning. Determined to bring order and structure to naval aviation, Moffett and the BNA developed procedures for procuring and testing aircraft components, identifying and painting airships, and maintaining, repairing, and salvaging aircraft. The BNA also promoted pilot safety and improved shore stations and installations. A proponent of innovation, Moffett authorized pioneering research in aerology, aviation medicine, and radiotelegraphy. He defended naval aviation against congressional and naval opposition, battling successfully to prevent deficiencies in personnel, supplies, and appropriations.

During and after World War II, the BNA expanded the scope of its activities. During the war, it inaugurated a comprehensive pilot recruitment and training program—which laid the foundation for the wartime expansion of the Naval Aviation Corps. Following Moffett's legacy, the BNA continued to sponsor research and managed the introduction of radar, jet propulsion, satellites, helicopters, titanium alloys, and other innovations. It also worked closely with the aerospace industry on research, design, and production. The BNA continued oversight of naval aviation until 1959, when the new Bureau of Naval Weapons absorbed its functions.

Daniel E. Worthington

See also

Moffett, William Adger; U.S. Marine Corps Aviation; United States Navy, and Aviation

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Burma

Protracted air campaign in support of ground operations during World War II. At the outbreak of war, Allied air defenses in Burma consisted of a single squadron of Brewster Buffaloes and the Curtiss P-40s of the American Volunteer Group (the famed Flying Tigers). They faced large numbers of Japanese aircraft based in Thailand and Indonesia. The air campaign opened in late December with Japanese attacks on the city of Rangoon that caused almost 30,000 civilian casualties.

In mid-January 1942, Japanese ground forces advanced into Burma supported by the Third Army Air Division. Although outnumbered, the Allied air forces in general fought well, but Japanese attacks on bases took their toll, and by late spring the campaign was over with the Japanese in possession of most of Burma. This cut the Burma Road, the only viable overland communication route to China, forcing supplies for China to be transported by air over the "Hump" of the Himalayas.

The Allies launched several offensive operations in late 1942 and 1943 with only limited success. Of particular interest was the operation of jungle-trained Chindit forces under Brigadier General Orde Wingate, who penetrated deep behind Japanese lines and were supplied entirely by air for extended periods. Operations by the British XV Corps in the Second Arakan Offensive in January 1944 were also supplied by air.

In early 1944, the Japanese Fifteenth Army attacked from western Burma into India but was stopped by British and Indian troops at Imphal and Kohima. Both defensive positions were surrounded for long periods of time, again supplied by the large number of Allied transport aircraft in the area until eventually relieved by forces advancing from India. Chindit operations continued, including the construction and operation of the Broadway air base behind Japanese lines. Broadway overstepped Allied capabilities, however, and Japanese air attack destroyed the aircraft based there.

By July 1944, Allied air strength had increased to 64 RAF and 26 U.S. squadrons, and a major Allied offensive was imminent. The most prevalent Allied aircraft were Hurricanes, but Spitfire, Beaufighter, P-40, and P-47 types contributed significantly, along with a variety of bomber aircraft. Unlike many of the well-known air battles in the Central and Southwest Pacific, Japanese air units were army units flying such aircraft as the Kawasaki Ki 43 and Ki 44.

The Japanese effectiveness had been spent in the Imphal and Kohima battles; the Allied advance, primarily by British, Indian, and Chinese forces, was hard-fought but steady, interrupted only by the monsoon season. It was supported by overwhelming airpower. Rangoon finally fell on 2 May 1945, and the campaign in Burma came to a close. Planned Allied operations in the theater against Malaya and Singapore had not begun when the war ended.

Frank E. Watson

See also
American Volunteer Group; Hump Airlift

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Busemann, Adolf (1901–1986)

German engineer; born in Lübeck, Germany, in 1901. After earning his Ph.D. in 1924, Busemann worked at the Max Planck Institute from 1925 to 1931 with Ludwig Prandtl. From 1931 to 1935, he taught at the University of Dresden and was involved in aerodynamic testing at the Göttingen wind tunnel laboratory. While there, he discovered that thin aerofoils delay and reduce drag as an aircraft approaches Mach 1. He later pointed out that swept-back wings might provide a solution to the vibration problem.

From 1936 to 1945, Busemann worked at the Hermann Goering Aeronautical Research Center in Völkenrode. In 1947, he came to the United States through Operation PAPERCLIP and later worked for the National Advisory Committee for Aeronautics (NACA) as chief scientist at Langley Field, Virginia. The successful application of his expertise was demonstrated in the design and production of the F-86 Sabre. Busemann remained with NACA/NASA until 1964. He then taught aeronautical engineering at the University of Colorado until 1971, when he retired. He died in 1986.

Guillaume de Syon

See also
Lippisch, Alexander Martin; Mach, Ernst

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Bush, George Herbert Walker (1924–)

Lieutenant junior grade, U.S. Naval Reserve, later U.S. president. He flew 58 combat missions in the Pacific during World War II. Holder of Distinguished Flying Cross, Air Medal with two Gold Stars, and Presidential Unit Citation awarded to USS *San Jacinto.* Later became forty-first president of the United States (1989–1993). Father of George W. Bush, forty-third U.S. president (2001–).

George Bush was born 12 June 1924 in Milton, Massachusetts. Enlisting in the Navy on his eighteenth birthday, he was not yet 19 when he earned his wings to become the youngest naval aviator of his time.

Assigned as a photographic officer to Torpedo Squadron 51 (VT-51) aboard the light aircraft carrier USS *San Jacinto* (CVL-30), he flew the Grumman Avenger. His ship was part of Task Force 58 and took part in seven major operations ranging from the Marianas to Okinawa. VT-51's executive officer, Legare Hole, described Bush as "an exceptionally good pilot" who was also a "smart fellow." Additionally, Bush was well liked by the squadron's officers and enlisted men.

The mission of 2 September 1944 against a Japanese radio station on ChiChi Jima in the Bonin Islands is a fine example of Lieutenant Bush's war. As described in his Distinguished Flying Cross citation, his actions were courageous and disciplined. The antiaircraft fire was especially intense as he and his two crewmen attacked the facility. Their Avenger was hit at the start of his dive, but Bush elected to continue the attack despite the aircraft's being on fire. Their bombs caused damaging hits to the Japanese facility. One crewman was killed in the crash, and the other's parachute failed to properly open; Bush was the only survivor. After landing in the water, he was protected by circling aircraft until being rescued by the submarine USS *Finback* (SS-230). He would go on to a distinguished career in public service, holding America's highest elected office.

Scott R. DiMarco

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C

Cactus Air Force

Allied aircraft on Guadalcanal (August 1942–February 1943). U.S. Marines landed on Guadalcanal on 7 August 1942. The Allied code name for the island of Guadalcanal was CACTUS, and the air units based on that island at newly won Henderson Field soon unofficially assumed the name Cactus Air Force. Operating on a logistical shoestring, Cactus succeeded in maintaining a land-based air presence over Guadalcanal in the most crucial days of that campaign. It achieved an effect out of all proportion to its numbers. On several occasions the operations of the entire Japanese Combined Fleet centered on eliminating Cactus Air Force and its base at Henderson Field.

Frank E. Watson

See also
Guadalcanal

Cambodia Bombings

Secret U.S. bombing of North Vietnamese sanctuaries in Cambodia. By the mid-1960s, North Vietnamese and Vietcong units had established base areas in eastern Cambodia from which to launch attacks into South Vietnam. In March 1969, President Richard Nixon, with the tacit approval of Cambodia's Prince Norodom Sihanouk, ordered bombing of these base areas to take pressure off the ongoing U.S. troop withdrawal from South Vietnam and to put pressure on the North Vietnamese to enter serious negotiations. Code-named Operation MENU, bombing would continue until Congress cut off funds for Cambodian operations in August 1973. By the time the MENU bombings ended, B-52 bombers had flown 16,527 sorties and dropped 383,851 tons of bombs on Cambodia.

Although elaborate measures were taken to keep the bombings secret lest their revelation fuel antiwar protests, the *New York Times* published a story about the bombings in May 1970, sparking heated debate about the legality and morality of the raids. The news infuriated Nixon, and the administration became obsessed with plugging information leaks to the press. The telephones of several journalists and government officials were wire-tapped, beginning the legal activities and coverup that would ultimately lead to the Watergate scandal, Congress's demand for Nixon's impeachment, and Nixon's unprecedented resignation.

The bombing of the Cambodian base areas and Cambodian attempts to constrain North Vietnamese expansion led to unrest within Cambodia, and on 18 March 1970 Prince Sihanouk, who was not in Cambodia at the time, was deposed by General Lon Nol.

James H. Willbanks

See also
ARC LIGHT; Ho Chi Minh Trail

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Camm, Sydney (1893–1966)

British aircraft designer. Born on 5 August 1893 in Windsor, Camm was apprenticed in woodworking, though he was also heavily involved in early aeronautics. In 1914, he joined the Martinsyde Aeroplane Company, eventually undertaking major design tasks there.

Camm joined the Hawker Engineering Company in 1923 as a senior draftsman, becoming chief designer only two years later. Camm's biplane designs were notable for their integrated elegance, imaginative conception, and structural strength allied to simplicity and stringent weight control. His Hart family of two-seaters, and related single-seat Fury types, broke new ground in performance and user-friendliness.

By 1933, Camm realized that biplane fighters had reached the limit of their useful development and began design of a monoplane that became the Hurricane. Even as this descendant of his earlier types entered production in 1938, Camm was working on its all-metal monocoque successor, the Typhoon, which he further developed into the Tempest and Sea Fury, the fastest and most robust British piston-engined fighters.

Although Camm quickly appreciated the jet engine's potential, his service designs actually formed the second and third generations of jet fighters. The Royal Navy's straight-wing Sea Hawk was followed by the very successful Hunter, which many hold to be the most elegant jet fighter of all time.

Government decisions frustrated Camm's desire to produce supersonic jets. Instead, in 1958 he initiated the revolutionary design, combining fast jet performance with VTOL operating characteristics, which became the Harrier, and witnessed its success before his death in Richmond, Surrey, on 12 March 1966.

Paul E. Fontenoy

See also

British Aerospace Harrier; Hawker Aircraft; Hawker Fury; Hawker Hunter; Hawker Hurricane; Hawker Typhoon and Tempest; Sopwith, Thomas O.M.

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Canadian Air Force (Royal Canadian Air Force)

The air component of the unified Canadian Forces. The Canadian Air Force supports a variety of domestic and international operations by providing an operationally ready, multipurpose, and combat-capable force. Its roles include surveillance and control of Canadian airspace; worldwide airlift; support to land and sea operations; and humanitarian operations. A special task of the Canadian Air Force is search and rescue throughout the expanses of Canada.

The Canadian Aviation Corps was formed in 1914 and was sent overseas early during World War I. Flight training began in Canada in 1915. In 1920, the Royal Canadian Air Force (RCAF) was established. With Canada's declaration of war against Germany in 1939, the RCAF hosted the British Commonwealth Air Training Plan. Canada trained 131,533 aircrewmen. Canadian airmen fought throughout the Battle of Britain and in all air campaigns in Europe. By D-Day, 33 bomber, fighter, and coastal squadrons participated in the aerial campaign to retake Europe.

The RCAF received its first jets, de Havilland Vampires, in 1948. In 1950 it joined the UN forces fighting in Korea, flying airlift missions and logging more than 34,000 flying hours. As the Cold War threatened North America, a U.S.-Canadian air defense agreement was signed in Washington, D.C., on 12 May 1958. This established the North American Air Defense Command.

In 1968, the RCAF was merged into the Canadian Forces. Canada has participated heavily in international peacekeeping efforts throughout the world. The Canadian Air Task Group flew against Iraq from Qatar during Operation DESERT STORM. During the Kosovo operation, Canadian CF-18s flew from Aviano Air Base, Italy. Equipped with precision-guided munitions, Canadian fighters led multinational packages against Serbian forces. At the same time, Canadian Forces members stationed in Geilenkirchen, Germany, with NATO AWACS supported the campaign.

The annual operating budget for the Canadian Air Force is approximately $2 billion. There are 14,500 members in the regular forces, with a small reserve. The Canadian Forces possess 122 CF-18 Hornets, 21 CP-140 patrol aircraft, 27 CT-133 trainers, 59 transports, and 140 helicopters. Thirteen wings are located across Canada, and a Canadian element is located in Geilenkirchen supporting NATO AWACS.

James M. Pfaff

See also

British Commonwealth Air Training Plan

Cant Aircraft

In 1921, the Cosulich family of Trieste decided to enter the aviation business. Already active in shipping and shipbuilding, they followed the same pattern by establishing first an air taxi service (SISA, 1921) and then a seaplane workshop at Monfalcone (within the existing Cantiere Navale Triestino, or CNT; 1923). SISA trained pilots for the Regia Aeronautica (the Italian air force) using CNT.7 and Cant.18 biplanes; from 1926 it added airline services, using the Cant.10 and Cant.22 cabin seaplanes. The workshops survived on license production and prototypes.

In 1930, CNT merged with other shipyards to form the Cantieri Riuniti Dell'Adriatico (CRDA), but aircraft continued to use the Cant designation. In 1933, CRDA was acquired by state conglomerate IRI, and Italo Balbo persuaded Filippo Zappata (1894–1994), then working with Blériot, to become chief designer. In the following nine years, CRDA flew 18 new types that garnered 40 world records; it also added a landplane factory, test department, and airfield as the workforce grew from 350 to 5,000. The Cant Z.501 (1934) and Z.506 (1935) seaplanes and Z.1007 landplane bomber (1937) became the standard Italian types in their categories. Zappata saw wooden airplanes as a temporary necessity, and his new designs were conceived with all-metal construction, including the Z.1018 bomber twin, Z.511 four-engine floatplane airliner, and Z.515 twin floatplane.

Around 1939 Zappata became disillusioned with CRDA and started negotiating with Breda, which he joined in 1942; in addition, military requirements fluctuated. The Z.1018 started in wood as "flying mockup," developed as a very different wooden preseries, and metamorphosed into metal for production—but with bomber, torpedo-bomber, and night-fighter variants. Not surprising, none of these types became operational before the Italian armistice in 1943. The ensuing German occupation and USAAF raids in March-April 1944 stopped all production, and only the shipyard was rebuilt after the war.

Gregory Alegi

See also

Balbo, Italo; Blériot Aircraft; Breda; Italian Aircraft Development; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II)

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Cape Canaveral

Home of the Kennedy Space Center, on the Florida coast, and center stage for U.S. space launches since the late 1950s. It hosted the early—and unsuccessful—satellite launches by the U.S. Army, as well as the Apollo lunar launches. Today, "the Cape" is the site for many U.S. satellite and space shuttle launches. Its massive runways allow the space shuttle to end its journey where it begins, for optimal turnaround.

Cape Canaveral is also home to the Vehicle Assembly Building of the National Aeronautics and Space Administration (NASA). The structure, more than 30 stories high, is where the Apollo rockets were assembled and the Space Shuttle and other NASA projects are prepared for launch.

President John F. Kennedy was one of NASA's biggest advocates, and in the days following Kennedy's assassination President Lyndon Johnson made the controversial decision to rename the site Cape Kennedy in honor of the fallen president. The name stuck until 1973, when the U.S. Board of Geographic Names responded to a campaign by the Florida legislature to restore the original name.

Erich Streckfuss

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Cape Engano, Battle of (1944)

Carrier engagement on 25 October 1944 northeast of Luzon, Philippines, during the Battle of Leyte Gulf.

As part of the Japanese operations that resulted in the massive Battle of Leyte Gulf, Admiral Jisaburo Ozawa's carrier force sailed south from Japan's Inland Sea on October 20 primarily as a decoy force. When reconnaissance aircraft located the Japanese carriers, most of Admiral William Halsey's U.S. Third Fleet moved northward to intercept. The battle was lopsided, with 787 U.S. naval aircraft opposed by only 29 Japanese. Although the U.S. bombing performance was below standard given the number of attacking aircraft, massive strikes sank the *Zuikaku, Chiyoda, Chitose,* and *Zuiho.* The remainder of the Japanese fleet, including the two hybrid battleship-carriers *Ise* and *Hyuga,* escaped during the night.

Even though he scored successes against Ozawa, Halsey has been roundly criticized for taking the bait of the empty Japanese carriers and allowing the Japanese surface fleet an opportunity for an advantageous engagement farther south at Leyte Gulf near the island of Samar. The Cape Engano action was followed closely by Admiral Chester Nimitz's famous message to Halsey: "Where is Task Force 34, the world wonders." Halsey's attention to the decoy carrier force while more or less ignoring the Japanese battleships to the south shows the extent to which naval thought revolved around airpower by 1944.

Frank E. Watson

See also

Leyte Gulf, Battle of

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The Caproni Ca.3 had a fine performance for 1917 and was used by U.S. flyers as well as the Italian air force. (Gregory Alegi)

Caproni Aircraft (Early Years)

Gianni Caproni followed the 1908 European tidal wave of interest in aviation by building a glider with his friend, Henri Coanda. His interest continued, and by 1910 he had entered the aircraft business. Prior to World War I, Caproni designed a series of slow open-fuselage aircraft and, like many Europeans, built Blériot and other aircraft design copies on which the firm survived. In 1914, he patented the world's first monoplane fighter, a shoulder-wing design that mounted a flexible machine gun on a high pylon, allowing fire over the propeller or vertically above the aircraft. It was flown as the Ca.20 in 1916 and is now displayed at the Museum of Flight in Seattle. But it was the series of large bombers produced by the firm during World War I that won the company lasting fame.

A variety of Caproni biplane and triplane bombers were designed to deliver a large bombload on Austro-Hungarian forces across the Alps. In each case, the three engines (usually 150-hp Isotta Fraschini V4Bs) were housed in individual nacelles. The aircraft had a crew of two pilots, a nose gunner, and usually a rear gunner. The wings spanned more than 60 feet, and the typical Caproni was 30–40 feet long. The Caproni bombers had a speed of about 100 mph and service ceilings in the range of 12,000 feet. On occasion, however, it could perform impressively, as on 23 February 1918, when Italian instructor Federico Semprini looped a Caproni to demonstrate its capabilities to the group of American students under Fiorello LaGuardia at Foggia.

In addition to operating with Italian *squadriglia* (squadrons), Capronis were sold to the British and served with the Royal Naval Air Service at Taranto. The French built the Ca.3 under license, and the U.S. Northern Bombing Group used the Ca.5. The Caproni was also recommended for production in the United States by the Bolling Mission. The Ca.5s built by Fisher Body in Detroit were powered by the Liberty engine.

Caproni continued to figure prominently in Italian aviation following World War I through to the jet age.

James Streckfuss

See also
Bolling Mission

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Caproni Aircraft (Post–World War I)

When armistice scuttled the plan for 4,000 Ca.5 bombers, Gianni Caproni (1886–1957) sought to replace military orders with airline sales and offered the ill-fated Ca.60 transatlantic flying boat (1920). Caproni concentrated production

It was not pretty, and it did not fly very fast, but the Caproni-Campini was Italy's first jet aircraft. (Walter J. Boyne)

at the Taliedo factory in Milan, and the wartime Vizzola factory became a flying school. Soon Caproni returned to bombers with the Ca.73 twin-engined inverted sesquiplane (1925), which finally ousted the wartime Ca.3 from Italian bomber units. Its layout was repeated on the Ca.79 and Ca.90 heavy bomber prototypes, designed to Guilio Douhet's "aerial battleship" concept.

The group reorganized in 1929 and began to acquire smaller firms. Moving from aircraft design to management, Caproni sought independence in the production process and bought engine and instrument makers, mining companies, wood industries, and weapons factories. A great believer in innovation, he sponsored many experimental types, including the Campini prototype (1940) that, although flawed by the lack of a gas turbine, was the world's second jet to fly.

Taliedo produced the Ca.100 basic trainer (1928) and the larger Ca.113 (1931), both also built under license in Bulgaria. In 1934–1939, the Ca.113 and its derivatives vied for the world altitude record, the Ca.161bis reaching 17,083 meters. From 1928, Taliedo also built a family of rugged high-wing monoplanes, including the Ca.101 (1929), Ca.111 (1932), and Ca.133 (1934), used with great success during the Ethiopian War.

Caproni Aeronautica Bergamasca (CAB), bought in 1929, produced designs by Cesare Pallavicino, including the Ca.309 colonial aircraft (1937) and Ca.313 light attack/advanced trainer (1939). Their success eventually led Pallavicino also to become technical director for Taliedo and Vizzola. In 1937, Caproni gained control of Reggiane, which introduced stressed-skin fighters with both Piaggio radials (RE.2000, 1939; RE 2002, 1940) and Daimler Benz inline engines (RE.2001, 1940; RE.2005, 1942).

By 1939, the Caproni group accounted for 28 percent of the Italian airframe workforce. In recognition of his contributions to aviation, Gianni Caproni was named count of Taliedo in 1940. Wartime production consisted mainly of various CAB types, in part exported to Germany, but considerations of industrial policy and engine availability prevented Reggiane and Vizzola from breaking into the fighter market. Among the many Caproni products were the CB midget submarines, used with some success in the Black Sea.

The postwar years were very bitter. Various executives were murdered by communists, and the Caproni brothers were forced into hiding; unions vetoed workforce cuts, destroying company finances. Unsupported by the government, Caproni diversified and before collapsing was able to complete the Ca.193 (1949) and F-5 jet trainer (1952). Caproni Vizzola, the last active branch, reentered the aviation field in 1962 with T-33 overhauls and progressed to build subassemblies for Aermacchi and Agusta. In 1968, it acquired Aviamilano and built its line of high-performance gliders that ultimately evolved into the C-22J light jet trainer (1980), the final Caproni aircraft to fly. The program was terminated by Agusta following its 1983 acquisition of Caproni Vizzola. Vigorously promoted by Maria Fede Caproni and her brother Giovanni, the company heritage is enshrined in the Caproni Museum, opened in Trento in 1992.

Gregory Alegi

See also

Caproni Aircraft (Early Years); Ethiopian War; Italian Aircraft Development; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II)

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CASA Aircraft

One of the oldest aircraft manufacturers in the world, CASA was founded in 1932 by José Ortez Echague. The principal customer initially was the Spanish air force, and the major production runs were of license-built foreign designs. These included the Breguet 19, of which more than 400 were built, the ubiquitous Dornier Wal flying boat, and the Vickers Vildebeeste.

Aircraft of German design were licensed after the Spanish civil war, and, along with many trainers, the CASA factory turned out Junkers Ju 52/3s, Messerschmitt Bf 109 fighters, and Heinkel He 111 bombers, all under CASA designations. (Many of the Messerschmitts and Heinkels were used in the film *Battle of Britain,* and some of these subsequently became warbirds.)

CASA continued to build aircraft under license, including the Northrop F-5A/B, but also had notable success with aircraft of its own design, including a series of twin-engine transports that began with the CASA.201 Alcotan. Other successful indigenous designs included the C-101 Aviojet trainer, the C-212 Aviocar twin-turboprop transport, and the larger CASA CN.235 tactical transport.

Walter J. Boyne

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Casablanca Conference

January 1943 meeting of Allied leaders in Casablanca, Morocco, to discuss war strategy, plans, and resource allocation. They reaffirmed the Germany-first policy, which meant that U.S. heavy bombers would be concentrated in Europe rather than the Pacific. The Casablanca Conference also decided on an invasion of Sicily instead of a cross-channel attack in 1943; thus, U.S. air bases could be located on Germany's southern flank. More important, the Casablanca Conference saw Major General Ira C. Eaker, commander of the Eighth Air Force based in Britain, give a spirited defense of U.S. air doctrine that dictated daylight precision bombing operations. British Prime Minister Winston Churchill, initially skeptical and desirous of the U.S. bombers joining RAF Bomber Command in nighttime area attacks, relented after hearing Eaker's formulation of round-the-clock bombing of the German heartland.

On 21 January, the Combined Chiefs of Staff issued the Casablanca Directive. It stated that the ultimate objective of the Allied bomber offensive was "the progressive destruction and dislocation of the German military, industrial and economic system, and the undermining of the morale of the German people to a point where their capacity for armed resistance is fatally weakened." The targets to be struck, in order of priority, were specified as German submarine construction yards, aircraft industry, transportation, oil plants, and other industrial facilities.

Phillip S. Meilinger

See also

Eaker, Ira C.; POINTBLANK; Strategic Bombing

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Cassino, Battle of (November 1943–June 1944)

Between November 1943 and June 1944, Allied air operations supported ground operations in Italy and raised moral questions regarding culturally significant targets in northern Italy. As Allies forces advanced northward in Italy, they found their way blocked by Rapido River and the massif of Monte Cassino, topped by the famous Benedictine monastery of the same name. Several Allied attacks were repulsed with heavy casualties. The dominating position afforded by the monastery atop the mountain and its excellent position for observation for artillery fire prompted Allied commanders to ask that the monastery itself be bombed. After much argument and anguish, the decision was made, and on 15 February 1944 135 American heavy bombers and 87 medium bombers destroyed the 1,000-year-old monastery. The subsequent ground attack failed. Postwar investigation seems to indicate that the Germans were not using the monastery itself, although it was impossible for the Allies to know this at the time.

Even heavier attacks on Cassino town, by 16 Allied air groups, destroyed that village in March, but again the ground attack failed. Cassino eventually fell to the Polish II Corps in May only after a Free French attack had outflanked it to the southwest.

The decision to bomb Cassino provides the classic example of the air planners' quandary: judging the value of the destruction of a target versus the possible cultural (or in other cases economic) value of the target to society.

Frank E. Watson

See also
Italian Campaign

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Caudron Aircraft (Early Years)

Founded by René and Gaston Caudron, one of the many pairs of brothers who seem to have gone into the aviation business in its early years. The Caudrons began their involvement in 1908 with a glider. They soon moved on and up to powered flight with a 25-hp tractor design.

Specializing in two-seater and multiseat types during World War I, the Caudrons equipped several of the early *escadrilles* (squadrons). The G 3 (G for "Gaston," the brother responsible for the design, later R models standing, of course, for "Rene") was a single-engine pusher powered by an Anzani radial. Its wings had the scalloped trailing edges common to the period. Directional control was achieved by a pair of rudders. The G 3 performed reconnaissance missions and dropped the occasional load of flechettes—light antipersonnel darts that looked like metal pencils with fins.

It was a G 3 equipped with floats that performed the first shipboard takeoff in French aviation history. The feat was accomplished from the deck of the *Foudre* on 8 May 1914 with René Caudron at the controls. The G 3 served until the end of the war as a trainer in French and U.S. flight schools.

The G 4 was a twin rotary-engine model that otherwise resembled its predecessor, the addition of the second power plant allowing a machine gun to be carried. The type was intended as an army reconnaissance aircraft and for artillery spotting duties but was also used on bombing missions and as a long-range fighter escort.

The most unusual Caudron, however, was the R 11. The R 11 was designed as a long-range escort for the Breguet 14 B2 bomber. It carried a crew of three and was powered by two Hispano Suiza or Renault engines. A total of 370 were built.

James Streckfuss

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Caudron Aircraft (Post–World War I)

Caudron produced excellent trainers and sportplanes to the designs of Paul Deville after World War I. The Caudron C.270 "Luciole" was produced in large numbers, and many were requisitioned for use as liaison aircraft when World War II broke out.

Deville's Caudron C. 280 Phalene (Moth) corresponded in name and appearance to its contemporary, the de Havilland Puss Moth. A four-seat touring aircraft, it could achieve a top speed of 115 mph on its 145-hp Renault four-cylinder Bengali engine. About 240 Phalenes were built, a sizeable number for an aircraft of its type for the period.

Under the direction of a new designer, Marcel Riffard, Caudron created the C.440 Goeland, a twin-engine trainer/transport that could carry eight persons at 186 mph with its twin Renault engines. More than 1,700 of the aircraft were built, for it continued in production during the German occupation and was operated by the Luftwaffe.

The most exciting of the Caudron designs were the elegant racers that won the Coupe Deutsch de la Meurthe contests in the mid-1930s. These in turn led to a series of lightweight fighters by which France hoped to overcome the handicap of not having engines comparable to the German Daimler Benz series.

Primarily of wood construction, these sleek, low-wing fighters were powered by Renault engines of only 450 hp but could achieve a top speed of 300 mph. Only about 60 were built. Some of them went to Finland, and others were used to equip a Polish squadron fighting in France. After France's collapse, a few were used by the Vichy French air force, and 20 were seized by the Luftwaffe.

The Caudron firm continued to operate through 1946.

Walter J. Boyne

See also
Caudron Aircraft (Early Years)

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Cessna Aircraft

American aircraft manufacturing company. The Cessna Aircraft Company was formed in 1927 by pioneer aviator and aircraft designer Clyde V. Cessna, who taught himself to fly in 1911. In 1924, after several years of exhibition flying and some successful early aircraft designs, he teamed up with fellow pioneer designers and manufacturers Lloyd Stearman and Walter Beech to form the Travel Air Manufacturing Company.

In 1927, Cessna left Travel Air to form his own company. After he achieved several commercially successful designs, the effects of the Great Depression caused sales to decline and forced Cessna to close down his company. Soon afterward, when a close friend was killed flying a custom-built air racer Cessna had designed and built, Clyde Cessna seemed to lose his enthusiasm for aviation and decided to retire permanently from the aircraft manufacturing business.

In 1934, Cessna's nephews, Dwane and Dwight Wallace, joined fellow engineer Jerry Gerteis in an attempt to revive the company. Their highly successful C-34, a clean, cantilever-wing single-engine monoplane, quickly breathed new life into the struggling aircraft company. Before long, Cessna Aircraft gained even greater success with the manufacture of the twin-engine T-50. More than 5,000 of these aircraft were sold during World War II to the U.S. and Canadian governments as advanced bomber-trainers.

After the war, Cessna Aircraft engineers wisely concentrated on the design and manufacture of small, inexpensive aircraft intended for civilian use. Numerous successful tailwheel designs, featuring side-by-side seating, rolled out of Cessna's Wichita factory, including such classics as the Models 120, 140, and 170 and radial-engine 190 and 195. In 1954, the twin-engine 310 with tricycle gear was introduced, soon followed by the single-engine four-place tricycle-geared 172, which became one of the best-selling commercial aircraft of all time. Another outstanding aircraft developed during this period was the extremely popular Cessna 150, undoubtedly the most widely used trainer of the 1960s and 1970s.

Cessna also somehow managed to capitalize on the considerably diminished post–World War II military market. Among its most successful military aircraft were the L-19/O1E Bird Dog, the T-37 Tweety Bird (Cessna's first jet aircraft), the A-37 Dragonfly, and the O-2A/B military version of the Cessna Skymaster.

By the mid-1980s, Cessna's sales and profits began to decline, attributed in large part to the general increase in liability lawsuits. This raised insurance premiums to a point where small aircraft could no longer be manufactured and sold at affordable rates. Consequently, Cessna stopped production of piston-engine aircraft in 1986 and, that same year, announced its acquisition by General Dynamics. Meanwhile, Cessna's manufacture of larger utility turboprop and jet aircraft, particularly the Citation business jet, continued to keep the company alive and well. In 1992, General Dynamics sold Cessna to Textron, Inc., under whose auspices Cessna continues to operate as a separate entity.

After more than 70 years, Cessna Aircraft has built more aircraft than any other company in the world. As it progresses into the twenty-first century, Cessna—a name that has become synonymous with general aviation—continues as an industry leader.

Steven A. Ruffin

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Chadwick, Roy (1893–1947)

British aeronautical engineer. Born on 30 April 1893 in Farnworth, Lancashire, Chadwick studied engineering at Manchester College of Technology before joining Alliott Verdon Roe as designer for A. V. Roe and Company in 1911. He worked closely with Roe on the firm's early aircraft, culminating in the very successful Avro 504, which after front-line service as a bomber became Great Britain's standard basic trainer from 1916 until 1932.

After World War I, Chadwick, as Avro's chief designer, developed light aircraft, including the record-breaking Avian; military types, most notably the Tutor basic trainer; and a series of successful airliners, initially based upon Fokker trimotors, that led to the Avro 652 and its military derivative, the Anson.

In 1937, Chadwick, who had experimented with structures for large all-metal aircraft for some years, designed the Manchester. This large, fast, heavily armed aircraft, capable of transporting a very substantial bombload over long ranges, entered production in 1939 and went into service the following year. It was not entirely successful because of deficiencies in its two Rolls-Royce Vulture engines. Chadwick proposed replacing these with four Merlins on a slightly extended wing. The result was the Lancaster, the most important and successful British heavy bomber of World War II; its final derivative, the maritime reconnaissance Shackleton, remained in front-line service into the 1980s.

Chadwick's final design was the Tudor, an interim pressurized transatlantic airliner. He died in the crash of a Tudor on a test flight on 23 August 1947.

Paul E. Fontenoy

See also
Avro 504; Avro Aircraft; Avro Lancaster

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Chamberlain, Neville (1869–1940)

Son of nineteenth-century British politician Joseph Chamberlain. Neville became mayor of Birmingham in 1915 and went on to serve as a member of Parliament (1918–1940), chancellor of the exchequer (1931–1937), and prime minister (1937–1940). He was the chief architect of Britain's policy of appeasement toward Germany's Nazi government and signed the notorious Munich Agreement in 1938, calling it "peace in our time."

Throughout the 1930s he resisted rearming on both financial and philosophical grounds and became bitter enemies with Winston Churchill, who urged support for the Royal Air Force. Only after Hitler took over the rest of Czechoslovakia did Chamberlain reluctantly drop his appeasement policy and actively support rearmament.

He was forced into declaring war when Hitler invaded Poland in September 1939 and had to call Churchill back into the government as First Lord of the Admiralty. After military debacles in Norway, Chamberlain resigned in May 1940 after failing to gain all-party support for a national government, paving the way for Churchill to take over.

Christopher H. Sterling

See also
Baldwin, Stanley; Churchill, Winston; Ten-Year Rule

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Channel Dash

The successful transit of the English Channel by the German capital ships *Scharnhorst, Gneisenau,* and *Prinz Eugen* from Brest, France, to Germany in February 1942. The operation was code-named CERBERUS by the Germans and was personally ordered by Adolf Hitler, who believed the ships were needed to protect Norway. Though they had long anticipated such a move, the British were caught by surprise and made only disjointed and unsuccessful air and naval efforts to stop the transit, hampered by German jamming and their own command failures. The British were embarrassed by their failure, but actually they were the winners. There was no planned invasion of Norway, and none of the German ships would again threaten British commerce in the Atlantic.

Grant Weller

See also
Atlantic, Battle of the; Fairey Aircraft; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Chateau Thierry, Battle of (1918)

Marked the real debut of the U.S. Air Service. Although the first American aircraft squadrons had operated in the relatively quiet Toul Sector since April 1918, and the 2d Company of the Balloon Section had been continually at the front since February, it was at Chateau Thierry that the 1st Pursuit Group and the I Corps Observation Group encountered heavy German opposition. It was also in this battle that units began to operate in a coordinated fashion rather than as independent units under close Allied supervision. For the first time also the squadrons were under an American commander, Colonel William Mitchell, who had tactical command of the observation units and administrative command of the pursuit group.

German forces at the battle included the famous Richthofen Flying Circus (Jagdgeschwader I). Although still formidable and more than capable of giving the neophyte Americans a hard time, the Flying Circus had suffered since Baron Manfred von Richthofen's loss in April and was by this time clearly past its prime. Lothar von Richthofen (the Baron's younger brother) observed during this period that he and Erich Lowenhardt were the about the only experienced pilots still remaining.

The American units acquitted themselves well and went on to greater achievements at Saint Mihiel and the Meuse Argonne.

James Streckfuss

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Chennault, Claire L. (1890–1958)

Major general in the U.S. military and leader of the famed Flying Tigers; he was a controversial Allied air commander in China during World War II. Chennault was born on 6 September 1890 in Commerce, Texas. He became a pilot in 1919 and specialized in fighter tactics. He retired from the U.S. Army in 1937 because of increasing deafness.

Following the 1937 Japanese invasion of China, Colonel Chennault became air adviser to General Chiang Kai-shek, accepting an offer to train fighter pilots for the Chinese air force. He returned to the United States in early 1941 to recruit American pilots to fly for the Chinese (which was done with the U.S. government's permission). Chennault formed the American Volunteer Group (Flying Tigers), which began flying against the Japanese on 20 December 1941 when their P-40B Tomahawks inflicted heavy damage on Japanese bombers attempting to attack Kunming. The Flying Tigers flew supplies, provided air cover for the Burma Road, succeeded in protecting the Chinese capital of Chunking, and fought the Japanese in the skies over southwestern China. Using surprise, mobility, precision flying, and unorthodox tactics, Chennault's pilots downed an estimated 286 Japanese aircraft while losing eight American pilots killed in action. Four other pilots were listed as missing, and three men were killed on the ground.

In April 1942, Chennault was recalled to active U.S. service, promoted to brigadier general, and given command of U.S. Army Air Forces units in China. These were consolidated as the Fourteenth Air Force in March 1943 under Chennault's command.

Major General Chennault resigned his command on 6 July 1945. He died in New Orleans on 27 July 1958.

James H. Willbanks

See also
American Volunteer Group; Curtiss P-40 "Warhawk"

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Claire Chennault will never be forgotten for his role as the founder of the American Volunteer Group, the famous Flying Tigers of World War II. (U.S. Air Force)

Cheshire, Geoffrey Leonard (1917–1992)

One of the most decorated British bomber pilots during World War II; one of only seven Victoria Cross winners to survive that conflict. After the war he founded what is now one of the world's largest providers of charity homes for the elderly.

Cheshire was a poor student at Oxford University before the war—far more interested in parties and pranks than studying. He took RAF flight training and flew the first of his 101 wartime missions just six days after the Dunkirk evacuation in June 1940. He was the first junior officer to win the Distinguished Service Order after continuing a bombing attack on the Cologne railyards despite damage to his Whitley of No. 102 Squadron. He became the youngest group captain in RAF history at age 24 and moved on to fly Halifax bombers with No. 35 Squadron, authoring a well-received book in 1943. He was a pathfinder pilot with the 617th Squadron (the famed Dam Busters) after 1943. After his one-hundredth mission, he was awarded the Victoria Cross. His next and last mission was as one of two British observers at Nagasaki, where he witnessed the dropping of the second atomic bomb in August 1945.

His postwar career took a very different turn when he was unable to find a suitable home for a dying older friend in 1948 and thus took the man into his own home. Others soon followed, and in 1948 Cheshire founded what became the Leonard Cheshire chain of charity homes for the ill and dying. There are now more than 250 of these in some 50 countries (the first outside of Britain was founded in 1955 in India).

Christopher H. Sterling

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Chinese Air Force and U.S. Aid

The Chinese Revolution of 1911 failed to establish a democratic republic, and China fragmented into warlord cliques that competed to control the Peking (Beijing) government and to maintain their independent satrapies during the early 1920s. Peking's use of airplanes to bomb targets during the Bailing Rebellion in July 1914 prompted several warlords to acquire aircraft and trained pilots. The greatest of these was Marshal Chang Tso-lin (Zhang Zuolin), the warlord of Dongbei (Manchuria). Clashes between the northern and central warlord factions in 1923–1924 involved as many as 70 planes. By 1925, the air force command of Marshal Chang consisted of five squadrons, staffed with foreign instructors and technicians, and 100 airplanes by Handley Page, Vickers, Curtiss, Vought, Ford, Junker, and Breguet.

In south China, Dr. Sun Yat-sen founded his second revolutionary government in Canton, Kwangtung Province, in 1917. In 1922, Yang Sen-yi, accompanied by two Americans, returned to Canton from the United States with hundreds of cases of aviation equipment and four Curtiss JN-series aircraft. An airplane shop was established, and a trainer designed by an American was manufactured with an American engine built at that shop—the first plane built in China. The Aviation Bureau was established in 1922, and in 1924 the Aviation School began. Under Sun's United Front, Soviet aviators taught Chinese cadets and flew alongside Chinese pilots during the Northern Expedition, led by Chiang Kai-shek in 1926 to defeat the warlords and unify China. Nationalist aircraft reconnoitered enemy defenses and supported attacking infantry troops. By the end of the 1920s, Chinese military leaders realized the importance of airpower.

During World War I, the powers sold arms to the Peking government. After 1917, fighting warlord factions resulted in such vast amounts of arms flowing into China that America urged the Western powers to halt arms sales to reduce the conflict. The powers could not agree on what constituted "military aircraft and accessories." The French thought commercial aircraft should be exempt; the U.S. Department of State sought to ban all planes, but in September 1920 the department allowed airplanes that were built strictly for commercial use. In January 1922, the U.S. Congress and President Warren G. Harding prohibited the exportation of arms and munitions of war to China, and in May the DOS again proclaimed that all airplanes were within the prohibition of embargo.

The Curtiss Company's sale of 12 planes to the Great China Airway Company created an outcry from the United Kingdom and Japan, which had forbid aircraft sales. The powers agreed that only commercial aircraft could be sold to China under the embargo. Despite the ban, arms and munitions, including airplanes, flowed into China because profits were enormous, thereby thwarting Nanking's attempts to unify the country.

In the 1920s, France and Great Britain sold aircraft to China, prompting U.S. manufacturers to complain. When the United States extended diplomatic recognition in 1928 to Chiang Kai-shek's Republic of China (ROC) government at Nanking, American manufacturers began to seek aircraft sales. The first modern American plane delivered to China since 1922, a Ryan "Brougham," similar to Charles Lindbergh's plane, was delivered in October 1928 to General Chang Wei-chiang (Zhang Weiqiang), director of the Canton Aviation Bureau, who took it on a flying tour that stirred great interest in American aircraft.

In 1929, a consortium of Americans created the Aviation Exploration Corporation, which signed an air-mail contract. Shortly afterward, the China Aircraft Company, representing Curtiss-Wright interests, joined other vendors to sell commercial aircraft in China. In April the consul at Canton reported that recently purchased planes had been fitted with machine guns, and other officials argued that if the United States did not sell the planes the Chinese would obtain them from other countries.

In March 1929, Nanking created the National Aviation Administration and in April adopted the designation Chinese Air Force (CAF). A national aviation conference in 1931 resolved to expand the air force and establish aviation schools and factories, and China turned to the United States for assistance. In August 1929, a reorganized CAF announced its intent to purchase 62 airplanes worth $1.25 million. The State Department approved 12 Chance-Vought Corsairs armed with machine guns and bomb racks, but it would not authorize armament. China threatened to buy British aircraft, and President Herbert Hoover intervened to ship the Chance-Vought aircraft, valued at almost $1 million. In April 1930, China purchased another 20 Corsairs with armament, bringing the total to 32 Chance-Vought planes in six months.

A number of Americans aided Chinese aviation development. Robert M. Short washed out of flight school and, after learning to fly by taking private lessons, became a second lieutenant in the Air Corps Reserve. He went to Shanghai in 1931 as a Boeing aircraft salesman. Short was hired as an instructor to oversee Chinese flight training and helped create a pursuit squadron. On several occasions he engaged Japanese planes and on 22 February was attacked by Japanese planes and became the first foreign pilot to die for China in Sino-Japanese hostilities.

Nanking bought German Junkers planes, but Chinese pilots feared them and preferred American planes for their quality and ruggedness. In February 1931, Chiang sent four air officers to the United States to tour aircraft factories and investigate aircraft purchases. That June, Nanking ordered 20 more Douglas observation planes, bringing the total to 43 U.S. military planes for the year. The 1931 CAF inventory showed eight squadrons of serviceable aircraft: 30 Douglas, 32 Corsairs, five Junkers, and 15 other types. Between 1931 and 1935, the Nationalist air force helped to crush the Chinese Communist Party (CCP). Following the Japanese takeover of Manchuria, the CAF avoided combat for fear that the Japanese would bomb Nanking. In February 1932, the Nanking government, reinforced with 30 planes from Canton, engaged Japanese air units over Shanghai—China's first aerial battle with a foreign power. On 28 February, superior Japanese forces attacked the Hangzhou air base near Shanghai. The CAF withdrew from Shanghai, as it did not want to risk losing more aircraft.

With unofficial American assistance, China aviation developed greatly from 1932 to 1936. China sought airpower to compensate for weak ground forces, tenuous loyalty of several warlords, and lack of training resources—a decision that was reinforced by the strength of Japan's airpower. Nanking diverted $11 million intended for the navy to the air force and announced a five-year program (1932–1936) to establish advanced aviation schools for pilots and mechanics, build the air force to 27 squadrons, and establish three aircraft factories and additional repair shops.

An observer of the Shanghai air battle of 1932, Captain George C. Westervelt, a leading U.S. naval aviator in World War I, wrote to T. V. Soong that if China had a larger air force the Japanese occupation of Shanghai could have been prevented. Westervelt suggested that China secure a high-ranking officer to advise on aeronautical matters.

China asked the United States to send an air mission to China. Colonel John Jouett, formerly in charge of U.S. Army Air Corps training, assembled flight instructors and a small staff of mechanics in 1932 to train military pilots for the CAF.

The Chinese cadets followed a program based on the sequence used by the USAAC: four months each of primary, basic, and advanced training. The program was a success—335 qualified cadets graduated under Jouett. By 1937, the graduates of the 1932 class were captains and squadron leaders. Nanking asked Jouett to reorganize the Nationalist Air Corps, and Jouett was given authority over all foreign aviation personnel in China.

The Jouett mission also aided American military aircraft sales to China. The five-year aviation program called for expenditures of more than $32 million. For 1933–1934, $2.333 million was appropriated for aircraft purchases. Major James H. Doolittle, the famous racing and stunt pilot, demonstrated the Curtiss P-40 Hawk in China, which resulted in an order for 15 Hawk pursuits. In 1933, China imported 90 percent of its planes from the United States—in the amount of $5.634 million. By 1934, China purchased 215 American planes: Northrop bombers, Douglas aircraft basic trainers, observation planes, Dolphin flying boats, a DC-2 transport, a Curtiss Condor transport bomber, Boeing pursuit planes, and Corsair observation/light bombers.

Italy emerged as a rival to the United States in training the Chinese after 1933, but in general the Chinese preferred American methods and aircraft. General Chou Chih-jou (Zhou Zirou), commander of the CAF, asked Roy Holbrook, an American adviser with the Central Trust of China, to help obtain American former military pilots as replacements. Holbrook wrote to his friend, Captain Claire L. Chennault of the USAAC, seeking recommendations for pilots.

In August 1936, a contingent of Americans whom Chennault recommended arrived and assumed direction of the assembly and repair departments at Hangzhou. Despite the efforts of the Nanking government, the political unity of China was tenuous during these years. In addition to the communist insurrection, Nanking had to deal with several "allied" warlord defections. After suppressing Canton's "independence" in 1936, the Nanking government assimilated Canton's air force and aviation school, where American instructors continued to teach. By December 1936, the Nationalist government had nearly consolidated its control over China's factions (except the CCP). All provincial air arms were under the control of the CAF, which had a total of 645 aircraft in 12 tactical squadrons, several modern aircraft factories and aviation schools, as well as 262 useable airports.

Japan denounced U.S. aviation activity in China and criticized the construction of air bases on China's coast opposite Taiwan (a Japanese colony taken from China in 1895) and of the aircraft factory at Hangzhou. The attempted kidnapping of Chiang Kai-shek in December 1936 led to talks in 1937 between communists and Nationalists that hinted at collaboration against Japan. This threat to Japan's economic ambitions in China prompted the so-called Marco Polo Bridge Incident, the pretext for Japan's attack on China in July 1937—the start of the Sino-Japanese War.

In July 1937, the CAF comprised 700 planes, approximately 440 of U.S. manufacture, and most CAF group commanders had trained under Americans. Japan had about 1,530 army and navy aircraft and deployed about 400 in the Chinese theater. After hostilities erupted, Chinese aircraft attacked Japanese ships in Shanghai Harbor, and there was intense fighting over Shanghai and Nanking. In the last half of 1937, the American-trained pilots of the CAF strongly resisted Japan; in more than 50 skirmishes they shot down or destroyed about 150 Japanese planes. By December the CAF had lost a reported 131 planes—most of its combat aircraft—without acquiring replacements to match Japan's.

After the Sino-Japanese War began, the United States continued to export aircraft and war materials to both China and Japan. U.S. willingness to sell modern aircraft to China led Tokyo in August 1937 to blockade Chinese ships in most Chinese coastal waters, with assurance that "peaceful commerce" carried by third parties would be respected. Japan's blockade was challenged by U.S. Secretary of State Cordell Hull, who noted that neither country had declared a state of war and that only belligerents could impose a blockade effecting third-party nations.

President Franklin D. Roosevelt, sympathetic to China, sought to avoid a clash with Japan, and on 18 September 1937 Washington forbid U.S. government ships from transporting arms to China or Japan and warned other U.S.-registered vessels of the risks in such trade. Roosevelt allowed the Chinese to purchase arms in the United States with delivery effected via Hong Kong or Vietnam.

American policy thus weakened the CAF. Between 1 July 1937 and October 1940, the United States exported only 279 aircraft to China. The need for aircraft and aviation personnel—especially trained military pilots—led China to accept a Soviet offer of help, and from November 1937 to July 1940 the Soviet Union sold 885 aircraft including about 200 SB-type bombers. Four Soviet *eskadrilii* (squadrons), about 250 pilots, flew Polikarpov I-15bis and I-16 fighters with Chinese units and out of northern bases in China. When France fell in June 1940, the Soviet Union withdrew from China to prepare for its defense against Germany. This loss of aid came at the time of Japan's intensive bombing of Chungking (Zhongqing) in seeking to force China's surrender.

In August 1937, Claire L. Chennault arrived in China and accepted Madame Chiang's offer as adviser to the CAF, a position that placed him in command of China's aerial warfare with Japan. Chennault and several aviation business organizations recruited American and foreign pilots for the CAF. On 5 August, Tokyo protested that America aided in procuring more than 180 pilots and many aviation technicians for the CAF. In 1939, H. H. Kung, China's minister of finance, proposed sending American volunteer pilots similar to the Lafayette Escadrille of World War I. In the summer of 1940, China pressed America to increase aircraft sales. U.S. Secretary of the Navy Frank Knox recommended a $100 million loan and the sale of 500 airplanes to China. In October 1940, Chiang suggested that because the U.S. government could not send military pilots it might be permissible for China to recruit pilots in America. Chiang sent an air mission to the United States, composed of General P. T. Mow (Mao Pangzhu) of the CAF and Claire Chennault, to investigate the purchase of new fighter aircraft and recruitment of American pilots. Secretary of Treasury Henry Morgenthau discussed the possible deployment of U.S.-made bombers, to be used by China to bomb Japan, with T. V. Soong, P. T. Mow, and Chennault. Chiang then appealed directly to Roosevelt for 500 airplanes, including some B-17 bombers to bomb Japanese cities, just as Japanese gains in Southeast Asia increased Roosevelt's concern for China.

Dissention continued among Washington officials. Knox's request that American volunteer pilots be allowed to serve China was denied by Hull on the grounds of the earlier policy. Chinese and American officials proposed that American volunteer pilots go to China under passports that misstated their purpose for travel, and by December 1940 Washington agreed to provide China with many of the latest aircraft and authorized Chennault to solicit American military aviators, who would resign their commissions and volunteer to serve in the CAF. In the eyes of Japan, the United States had allied itself with China in a war against the empire.

Richard C. DeAngelis

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Chinese-American Composite Wing

In the six months following Japan's attack on China in July 1937, the best units of the Chinese Air Force (CAF) were destroyed. In 1938, Claire L. Chennault, a civilian adviser to the CAF, assembled an international squadron of pilots as flight leaders for Chinese units. The Japanese A6M2 Zero, introduced in 1940, was superior to CAF aircraft. In October 1940, Chennault visited the United States in search of planes and pilots; the result was the American Volunteer Group (AVG)—military pilots who resigned their commissions to fly for China—and 100 P-40 aircraft.

The AVG was disbanded on 4 July 1942 and replaced by the China Air Task Force (CATF) under then-commissioned Brigadier General Chennault. The CATF consisted of four P-40 squadrons of the 23d Fighter Group plus the B-25s of the 11th Bomb Group. Their performance convinced General Henry H. "Hap" Arnold, chief of the U.S. Army Air Corps, of the benefits of providing combat aircraft for Chinese pilots.

The Chinese-American Composite Wing (CACW) was conceived by Chennault when the U.S. Fourteenth Air Force was formed in March 1943. As Chinese pilots lacked training and confidence to engage the enemy, the plan was to have an American commander, assisted by a staff of Chinese officers, head a special unit composed of Chinese and American pilots and crews. CACW plans called for a four squadrons of fighters (80 planes) and four squadrons of bombers (40 planes), all units of the CAF, to be under Chennault's command.

The 1st Bomb Group and the 3d Fighter Group of the CAF were formed on 31 July 1943, after American pilots arrived at Malir, India. One hundred Chinese cadets returned from training in the United States at Luke Air Advanced School to fly for the CACW. Training began at Malir using old AVG P-40s and B-25s that had been used in China. The Chinese and American officers had segregated facilities, and each maintained separate quarters and mess from enlisted personnel. The CACW was activated on 1 October 1943, shortly after 24 new P-40Ns and 12 B-25s were deployed to China; three additional squadrons of the CACW trained at Malir.

In November 1943, the 2d Bomb Squadron began combat operations; a Thanksgiving Day raid on Japan's largest air base in Formosa (Taiwan) shot down 14 Japanese planes and destroyed more than 50 without loss of any CACW planes. CACW pressure on Japanese forces in eastern China prompted Japan's Operation ICHI-GO to capture Chennault's eastern China airfields employed for B-29 bombing raids on Japan after June 1944. By late December 1944, as CACW pilots began the transition to the longer-range P-51C Mustangs, the CACW had lost 20 fighters to Japanese pilots and 35 fighters and eight bombers to enemy ground fire; no bombers were lost to Japanese interceptors, a tribute to the B-25 crews and the fighter escorts.

The CACW unofficial combat record included 190 Japanese aircraft destroyed in the air, 301 on the ground; more than 2,500 vehicles were damaged or destroyed; many bridges, railroads, and enemy facilities and troops were destroyed; and several hundred thousand tons of shipping was sunk. The CACW produced eight air aces, including three Chinese aces. Chennault's experiment yielded substantial results before it was disbanded on 19 September 1945.

Richard C. DeAngelis

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Chinese Communist Air Force (People's Liberation Army Air Force [PLAAF])

Despite the end of the Cold War, even historical information about airpower in the People's Republic of China remains sparse and contradictory. Although the PLAAF traces its origins to 1924, when several individuals were trained at Whampoa and later received minimal training from the Soviet Union, there were no aircraft to speak of. Upon the 1945 defeat of the Japanese in World War II, the PLAAF was established, using captured Japanese aircraft and Japanese pilots as instructors. However, only about 200 pilots were trained, there was little in the way of structure, and there is no information about use of these aircraft during the civil war between communist and Nationalist forces.

Genuine organization began in July 1949 using 159 aircraft of 21 types abandoned by the Nationalists. The first commander was Liu Yalou with Commissar Xiao Hua, both men being chosen from the ground forces and signifying a strict subordination to the army that continues today. A Soviet mission to China in 1950 marked the start of massive assistance. Initially, this involved supplying Soviet units (which had fought air combat over Shanghai in April 1940 while wearing Chinese markings), followed by the dispatch of more than a dozen air divisions to provide interim air security and train the Chinese, who handed over their aircraft upon departure.

By mid-1951, the PLAAF had 1,050 aircraft in 17 divisions, including 445 modern MiG-15s. By the end of 1954, the Soviet Union had provided 3,000 combat aircraft, including jet and propeller fighters, propeller-driven bombers and attack aircraft, and at least 100 Il-28 jet bombers. These were organized into 28 air divisions comprising 70 regiments. A dozen academies and schools trained at least 6,000 pilots and many more support and maintenance staff.

China's first air operation came in January 1950 during the occupation of Tibet, when 12 C-47 and C-46 transports dropped supplies to the advancing infantry. This unit received Russian aircraft and was expanded into the 13th Transport Air Division, remaining active in Tibet through the end of 1952, flying 1,282 sorties. Later during 1953, the PLAAF also used Tu-2 bombers and La-9 fighters against "bandit" resistance in Sichaun and Gansu Provinces.

Contrary to widespread belief, Soviet pilots, not Chinese, flew the first MiGs to intervene in the Korean War at the end of 1950 and flew the great majority of sorties throughout the war. The first Chinese air regiment entered combat only in January 1951, attached to the Soviet 50 IAD (Fighter Aviation) and flew for only a few weeks before being relieved. In December 1951, the PLAAF finally committed the 1st Unified Air Army, with a strength of three fighter air divisions, commanded by Liu Zhen. This organization controlled all PLAAF assets committed to Korea, swelling to seven air divisions, including seldom-used propeller-driven fighters, bombers, and attack aircraft, as well as the units of the newly recreated North Korean Air Force. The Soviet pilots considered their Chinese comrades brave but poorly trained and completely unsuited for jet combat.

By July 1953, the 1st OVA (Unified Air Arm) flew 22,300 sorties (versus 63,229 for the Soviets) and fought 366 air combats, claiming 271 air victories with the loss of 231 of their own aircraft and 126 pilots. Eight Chinese pilots are known to have been credited with five or more air victories; their top ace was Deng Wang, with 10 victories.

Korean operations had barely ceased when the PLAAF resumed action against the Nationalist Chinese, evidence that they may not have been so badly punished in Korea as the West believed. During the successful Yijiangshan Campaign to seize Nationalist-held coastal islands, from 1 November 1954 to 18 January 1955 the PLAAF flew 288 sorties against Dachen and other islands, losing 19 aircraft to antiaircraft fire. The next combat went differently when the People's Liberation Army decided to capture the offshore islands of Quemoy and Mastu, precipitating the Taiwan Strait Crisis of July 1958.

The PLAAF was assigned the tasks of establishing local air superiority and of bombing the heavily fortified Nationalist islands; for the first time, they committed their new MiG-17F fighters. However, the Nationalists had also begun to receive modern F-86 fighters and had a significant advantage (they also had a monopoly of new heat-seeking Sidewinder air-to-air missles). The Sidewinder and the superior training of the Taiwanese pilots gave them a decisive edge. They claimed 32 MiGs shot down with a loss of four of their own, against a PLAAF claim of 14 Nationalist aircraft shot down with a loss of five MiGs. Though the truth is unknown, it is probably closer to the Nationalist version. The last air battle was fought on 14 October 1958.

During the 1960s, the PLAAF continued modernizing. From the mid-1950s, the Chinese had begun to build the MiG-17 fighter and Il-28 bomber aircraft under license, soon joined by the medium-range Tupolev Tu-16 bomber and other aircraft. From the early 1960s, they received the MiG-19, which they placed into mass production, including several original modifications. At the end of the century this aircraft, known to the Chinese as the J-6, remains the most numerous aircraft in service. They also received the first SA-2 SAMs from the Soviet Union, as well as helicopters and transports. Shortly before China's rupture with the Soviet Union, the PLAAF received a small number of MiG-21Fs, which were placed into production without a license—but only much later due to the dislocations of the Great Leap Forward and the Cultural Revolution, which disorganized the Chinese industrial base and military.

Also during the 1960s, the Chinese began a policy of providing military aid, particularly in aviation, to anti-Western Third World countries, a practice that continues. In 1962, China fought a serious border conflict in the Himalayas with India, but aviation was notably absent on both sides, probably due in part to lack of suitable bases, partly to lack of appropriate targets in the high mountains. During the Vietnam War, the PLAAF provided much training and assistance to the North Vietnamese, in return gaining experience, a chance to observe the developments in modern air warfare, and access to captured U.S. technology. According to the Vietnamese, the Chinese also stole modern Soviet equipment being transshipped to Vietnam, substituting their own older equipment. On a number of occasions, the PLAAF shot down U.S. aircraft that had strayed into Chinese airspace in the course of operations. Also, between 1962 and 1967 they shot down a number of Taiwanese U-2 and other reconnaissance aircraft over the Chinese mainland.

During the 1960s and 1970s, relations between China and the Soviet Union steadily worsened, reaching a nadir in 1969 with a major border engagement along the Ussuri River. Although there are no reports that either side used airpower (except for some transport helicopters by the Soviets), this period marked the end of Russian assistance. There are also murky hints in Russian sources that during the 1960s and 1970s the Soviets shot down a number of Chinese aircraft for violating Soviet airspace.

China also had a falling out with communist Vietnam, culminating in the so-called Punitive Invasion of 1979. The PLAAF provided major air support for this venture, and though details are lacking, it is generally known that even though Vietnamese air forces refrained from battle, their experienced and well-equipped antiaircraft defenses taught the PLAAF a sharp lesson.

The Chinese began to open to the West from the early 1980s, and the PLAAF began to benefit, receiving new Western technology, particularly modern helicopters from the United States, Britain, and France, new transport aircraft, and improved aviation missiles and avionics, the latter particularly from Israel. This has led China to develop expertise in modernizing obsolete systems, producing such aircraft as the J-7-III, essentially a 1960s-era MiG-21F airframe with 1980s-vintage engines, avionics, and weapons.

During the 1990s, alliances shifted once again, and the Chinese reestablished cordial relations with post-Soviet Russia, leading to new defense agreements and contracts. This includes the supply of 72 modern Su-27 and 30 Su-30MK jets, Il-76MD transports, and manufacturing licenses. There has been no real air combat, but the PLAAF and the PLAN-AF (naval air force) have been aggressive over the Taiwan Strait and the disputed Spratley and Paracel Islands in the South China Sea.

Information remains uncertain, but it seems that at the turn of the century the PLAAF consisted of about 45 air divisions of some 3,350 aircraft, the PLAN-AF 9 divisions and about 540 aircraft, including 180 J-8s, 570 J-7s (MiG-21), 2,100 J-6s (MiG-19), 450 Q-5s (MiG-19 derivative) fighters; 140 H-6 (Tu-16) and 260 H-5 (Il-28) bombers; and about 450 transports. Much of the equipment is obsolete, and the air transport and helicopter resources are inadequate. Chinese pilots are also believed to fly far fewer hours per year than is considered minimally acceptable in the West and in modern noncommunist Asian nations. Although Chinese airpower has taken remarkable strides, for the foreseeable future it will remain an unbalanced force, 40 years out of date but with gradual advancement in cutting-edge technology.

George M. Mellinger

See also

Fighter Air Corps; Ilyushin Aircraft; Korean War; Lavochkin Aircraft; Mao Tse Tung, and Airpower; Mikoyan-Guryevich Aircraft; Tupolev Aircraft; Yakovlev, Aleksandr S.

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Chkalov, Valeri Pavlovich (1904–1938)

Soviet test pilot and aviation pioneer. V. P. Chkalov was born in the village of Vailevo (since renamed Chkalovsk) on 15 December 1904. Chkalov joined the Red Army as an aircraft mechanic in 1919 and, despite being underaged, completed the Yegorevsk Military-Theoretical School for Aviators in 1922 and was commissioned as a captain. He quickly demonstrated extraordinary skill in aerial acrobatics.

In 1929, after a minor flying accident, Chkalov was briefly imprisoned and cashiered from the air force. Nearly two years later he was hired as a test pilot by the air force's Scientific Research Institute. In 1936, he led a team of three in completing a nonstop flight from Moscow to Petropavlovsk (Kamchatka) to Udd Island (now Chkalov Island).

In 1937, the same crew, headed by Chkalov, flew nonstop from Moscow over the North Pole to Vancouver. These exploits made Chkalov a national hero, and he was immediately named a deputy to the Supreme Soviet of the USSR. The following year he was killed in an air crash while flying the prototype I-180 fighter. Although it was officially ruled an accident, many questions have been raised about his death. According to Georgi Baidukov, his copilot on the transpolar flight, it resulted from the Polikarpov Design Bureau's deliberately submitting a substandard aircraft for testing in order to meet a deadline. Family members allege that the aircraft he was flying was sabotaged on Stalin's order, because Chkalov had spoken up on behalf of victims of the Great Purges.

William B. Green

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Churchill, Winston S. (1874–1965)

Britain's prime minister during World War II and a longtime student of airpower. To the despair of his wife and friends, Churchill actively sought his own pilot's license in the years leading up to World War I when serving as First Lord of the Admiralty, feeling he would better understand the growing naval concern with aviation if he himself could fly. He halted his efforts only shortly before he would have soloed, an action taken in the face of several fatal crashes by others. He returned briefly to flying in 1919 but gave it up for good after a crash that could easily have killed him.

But it was Churchill's actions while in various ministerial roles that demonstrated his interest; by the end of World War II, one authority concluded that he alone among the world's prime ministers had shown a real understanding of the meaning of air power. He promoted naval aviation and formed the Royal Naval Air Service just before World War I.

He even claimed to have invented the term "seaplane." From 1919 to 1920, he served as secretary of state for air (under Prime Minister David Lloyd George) while holding down the War Office. Upon taking that post, he stated that the Royal Air Force would remain independent (it had only become so the year before) and that "given superior thinking power and knowledge it must obtain the primary place in the general conception of war policy." He brought back Sir Hugh Trenchard as Chief of the Air Staff (he would remain for a decade), as both agreed military aviation needs should be paramount over civil transport concerns. He proved his point by supporting RAF supervision of British-occupied territories in the Middle East (in part to cut costs) and by supporting Trenchard's quest for a thriving air force equal to the army and navy.

During the 1930s, out of office, Churchill made his living by writing books and articles, some of the latter on aviation. Just a year before World War II began, he asked in a magazine piece whether airpower was decisive and concluded that the Spanish civil war demonstrated that Britain had to "acquire at the earliest possible moment an air force at least equal to that of any Power within striking distance of her shores." Out of power until after the war began, however, Churchill could only berate Parliament about the parlous state of British air defense in the face of the growing German air threat.

On taking the prime ministership in May 1940, Churchill's energies were pulled in many directions. Nonetheless, he was always open to ideas and means for supporting the hard-pressed RAF. His famous speech at the time of the Battle of Britain—"never have so many owed so much to so few"—even today brings home his view of the RAF's central position in Britain's survival. But he did more than use words or wear his air commodore uniform or visit front-line air units. By appointing his longtime friend Lord Beaverbrook as minister of aircraft production, he revitalized the British air industry to manufacture even more fighters (the top priority) and bombers. He had to determine the priority between Coastal Command and Bomber Command, almost always deferring to the latter in an attempt to get at the heart of German wartime production ability. Churchill was unerring in his support of Fighter Command's Hugh Dowding and Bomber Command's Arthur Harris, even when both were under attack from rivals.

During Churchill's second term as prime minister (1951–1955), the Air Ministry expanded more rapidly among the three services; air was the means by which Britain would deliver its growing nuclear capability. But that policy had been set by the previous Labour administration and was merely continued under Churchill. In 1952, however, the Churchill government promoted development of jet bombers over a fighter force—a decision to depend more on deterrence rather than defense.

Winston Churchill will live in history as one of the great defenders of freedom, a staunch advocate of air warfare during Britain's most perilous moment.

Christopher H. Sterling

See also

Beaverbrook, Lord; Britain, Battle of; Dowding, Hugh C.T.; Harris, Arthur T.; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Spanish Civil War; Ten-Year Rule; Trenchard, Hugh

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Civil Air Patrol (CAP, in World War II)

Established on 1 December 1941 for U.S. civilian air defense. The CAP searched for lost aircraft, provided emergency radio communication, exposed youngsters to aviation, and provided disaster relief. It was open to citizens 18 and over of good moral character and proven loyalty. The first volunteers were competent in flying, radio, mechanics, office work, and guard duty.

From bases ranging from New Jersey to Florida, the CAP watched for U-boats and either bluffed them by diving or reported them to military aircraft. In early summer 1942, CAP planes began carrying bombs and depth charges. Planes of the CAP actually sank two submarines before the Navy began protecting the sea lanes in August 1943. Over 18 months, the CAP flew 24 million miles over water, spotted 173 subs, attacked 82 with bombs or depth charges, and reported 17 floating mines. It spotted 363 survivors of ship sinkings or aircraft wrecks and reported 91 ships in distress. Twenty-six CAP personnel lost their lives in coastal patrol. After 1943, search and rescue missions flew 24,000 hours and located 100 aircraft.

From October 1942, CAP tracked infiltrators from Mexico; its 4,720 missions reported 176 unidentified aircraft and 6,874 unusual activities. CAP also managed and maintained 215 airfields, serving as guards, mowing grass, patching potholes, and so on. Building 81 new airfields, CAP also lengthened runways, installed lights, and built hangars on 108 others. Other support included courier service, towing targets, and flying for searchlight practice.

By war's end, 135,000 people served in the CAP.

John Barnhill

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Civil Aviation: Impact of Military Advances

Civil aviation has gained more from military advances than vice versa, due largely to the high cost of and government support for military priorities in wartime. The exigencies of war increase the pace of technical advances and aviation.

World War I saw great advances. The aircraft of 1914 were outclassed in every way by those flying in 1918. This was true in virtually all measures—speed, load-carrying capacity, range and effective ceiling, and especially in the reliability of engines and aircraft structures. The trend toward air-cooled rather than water-cooled engines and the increasing use of metal in aircraft structures were two important steps. So was the introduction of mass production of aircraft, which greatly increased efficiency and quality standards.

Most airliners (and thus airlines) developed after World War I with government support (except in the United States and Britain, where Minister of Aviation Winston Churchill felt companies should literally fly on their own). This led to several commercial operations in 1920 that had foundered by 1923. The British government then played a central role in starting and supporting Imperial Airways (1924–1940) to catch up with European airline expansion. U.S. reluctance to put government funds into air transport in the early 1920s meant that Europe led in airline innovation for much of the interwar period.

Yet mainland Europe took a different route, drawing from the wartime precedent of government support for military aviation. In France, Holland, and other European countries, government subsidies for fledgling air transport operations were usually assumed and forthcoming. Likewise, when the German Lufthansa firm developed out of several earlier airlines in 1926, it was substantially supported by the government, which owned more than a quarter of the airline.

Simultaneously, many early airliners were modified from military models because they were readily available, and it was soon evident that bombers and transports have parallel aims—to carry a heavy load as cheaply as possible over a long distance. In Britain, the first airliners used by Imperial's short-lived commercial predecessors were modified from D.H. 4 and D.H. 9 single-engine biplane bombers; the four-engine HPW 8 transport of 1920 was based on the Handley Page 0/400 bomber. Germany and France also used lightly modified single-engine military models, though the French were able to introduce a larger transport based on the Farman "Goliath" bomber.

Military flying was starved for funds between the wars, and U.S. military services undertook some spectacular endurance flights in an attempt to regain public support while testing their capabilities. The U.S. Navy's 1919 transatlantic flight with four NC flying boats was the first, though soon eclipsed by the British nonstop flight with a Vickers Vimy aircraft later the same year. In 1922, the U.S. Army created a 4,400-mile model airway covering 35 cities and used it for training and transport purposes. The army, which allowed some civil pilots to use the airway as well, included 12 weather stations in a pioneering attempt to strengthen the connection between accurate weather forecasting and flight safety. A year later, two Army fliers using a Fokker T-2 twin-engine monoplane flew nonstop in 27 hours from Long Island to San Diego, demonstrating that such air distances were possible even with the crude equipment of the time (of course, the only cargo carried was fuel). And in 1924, four U.S. Army Douglas World Cruisers took off from Seattle in an attempt to fly clear around the world; two of them were the first to accomplish the feat weeks later. All of these pioneered what would become commercial routes when aircraft and facilities were up to the task of scheduled routes for passengers.

World War II had even more dramatic effects on postwar civil aviation. Development of radar by Allied and Axis powers would eventually be of tremendous value to civil flying and military and civil air-traffic control. Jet propulsion was first applied during the war but was applied to pioneering airliners only four years after the war ended. Swept-wing design and engines mounted in pods beneath the wing were ideas drawn from Junkers wartime designs that would prove important to postwar U.S. jet bomber and then jet airliner design.

Military development or improvement of numerous airports, combined with development of efficient long-range landplanes (bombers, patrol craft, and transports) spelled the doom of flying boats for civil and military applications. Expensive to maintain and less efficient than landplanes, flying boats served through and after the war for naval patrol purposes but could not survive airline efficiency demands past the 1940s, with only minor exceptions. Regular transatlantic flying became commonplace thanks to ferrying flights of men and aircraft. Improved means of all-weather flying, long-range navigation, and instrumentation all contributed. So did pressurization, applied in an airliner (the Boeing 307 "Stratoliner") in 1940 but first widely used in high-altitude long-range bombers during World War II (indeed, the Model 307 itself had developed from Boeing's B-17 bomber).

Many immediate postwar airliners grew directly from military designs. British interim transports included the York and Lancastrian, both based on the Lancaster bomber (same engines, wing, undercarriage, and tail) and the Halton, based on the Halifax bomber. But they offered too little payload for the expense of running their military engines and were soon phased out. In the United States, the B-29 heavy bomber led directly to the C-97 military transport and Boeing 377 "Stratocruiser" airliner (all three shared engines, wing, undercarriage, and tail).

Military leadership in civil aviation development continued after 1945, pushed by fear and the arms race brought about by Cold War tensions. Unlike the period after World War I, when military spending all but disappeared in the United States for two decades, post-1945 military aviation spending (save for a brief drop 1945–1950) continued at high levels.

USAF development of jet bombers, especially the Boeing B-47, had a direct impact on later jetliner development in at least two ways. First, the engine layout developed by Boeing (drawn in considerable part from German prototype development late in World War II) was followed in the company's pioneering Dash 80 prototype for the 707 airliner series. Engines slung in pods below the wing had several advantages over other options (such as buried in the wing roots, as with Britain's pioneering Comet, or hung on the back, as with the French Caravelle) that were made clear in wind-tunnel tests and actual experience with the B-47 bomber fleet. When the B-47 was joined by the B-52, the Air Force needed an aerial refueling tanker faster than the four-piston-engine KC-97. In 1954, the Air Force ordered the KC-135 derivation from the basic 707 airframe, providing badly needed support to Boeing, which had financed the prototype on its own. Boeing soon obtained government permission to launch the 707 airliner using some of the same rigs in the government-owned Renton manufacturing facility.

Closer cooperation was evident elsewhere. The Soviet Union made a pattern of developing early jet airliners from existing bomber designs, thus saving time and expense in getting the civil versions into service. The Tu-16 twin-jet bomber (called "Badger" by NATO) became, with only marginal changes, the pioneering Tu-104 jetliner in 1955. Likewise, the huge turboprop Tu-95 long-range bomber (dubbed "Bear" by NATO) was the forebear of the Tu-114 long-range airliner. Both aircraft—and several later Soviet airliners—retained the overall bomber airframe and glazed nose windows originally intended for bombsighting.

Since its earliest days, military aviation has provided impetus to the development of airlines worldwide.

Christopher H. Sterling

See also

Civil Aviation: Impact on the Military

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Civil Aviation: Impact on the Military

Although military advances generally guide those in civil aviation, there have been important exceptions. In Germany, the DELAG firm was formed in 1909 to provide passenger airship service but also provided training for military Zeppelin crews. But the most significant developments occurred during the 1919–1939 period, between the world wars. Aviation development, especially pure research, was driven more by commercial than military priorities during this time. Military budgets were small in many countries until the eve of World War II.

U.S. aeronautical research centered on the Department of Commerce's National Bureau of Standards and focused on improving engine reliability and aircraft instrumentation and, in the 1920s, developing an airborne radio direction finder for the War Department. The National Advisory Committee for Aeronautics, formed in 1915, focused on the continued shift to manufacture aircraft from metal rather than wood; away from biplane and more to monoplane structures; development of stressed-skin construction; devising retractable undercarriages; improving wing design; and refining controllable-pitch propellers. Results of this government work were soon applied by civil and military fliers alike.

Policy changes helped place civil aviation in the aviation vanguard. The Kelly Air Mail Act of 1925 shifted air mail from government to fledgling airlines that needed the business and revenue. (Indeed, when the Army briefly took back airmail flights in 1934, its terrible performance illustrated how civil aviation loomed over the military.) Then the presidentially appointed Morrow Board of 1925 led to passage of the Air Commerce Act of 1926, the first federal regulation of civil aviation and the source of funding for five-year development programs for struggling army and navy aviation programs.

Most of the important research during this era was accomplished with private support. Public attention was drawn to the annual Detroit Aviation Society/Ford Reliability Tours (held from 1925 to 1931, when the Depression brought them to a halt). Publicity and the chance for a prize led to concerted efforts to improve airplane reliability on all levels, and submissions came from Europe as well as the United States. The army often provided fliers to accompany the contestants on some legs. The participating airplanes were far more capable than most military models of the period.

The Daniel Guggenheim Fund for the Promotion of Aeronautics spent $2.8 million from 1926 to 1930 in a multifaceted program of immense importance to civil and military flying. Although focused at first on civil aviation needs, it turned in 1928 to more fundamental problems in aerodynamics. Its grants to eight universities improved aviation engineering education. Guggenheim's Model Air Line project allowed Western Air Express to purchase Fokker trimotors to use between Los Angeles and San Francisco. As with the Army model airway that preceded it by four years, this airway focused on the importance of an organized aviation weather service to regular air operations, whether civilian or military. With Army pilot James Doolittle doing the legwork, Guggenheim supported vital research into blind and instrument flying. The fund also supported an international safe-aircraft competition and helped to promote the image of aviation in national air tours by Richard E. Byrd (1926) and Charles Lindbergh (1927).

Racing was a focus of public interest and helped to improve airplane design during the interwar period. Various air races in the United States often featured military as well as civilian pilots. Internationally, the Schneider Cup Trophy air races of 1913–1931 (they were suspended during World War I) were a major spur to seaplane development, attracting both private and government-supported military entries. The annual competition prompted substantial improvement in engines, aerodynamics, and streamlining. The series was finally won definitively by the British with the graceful Supermarine racers designed by R. J. Mitchell, which were immediate predecessors of the Spitfire fighter.

In structure and streamlining, civil air transports outpaced military designs. The process began with the classic Junkers F.13 of 1919, perhaps the most widely used airliner in the 1920s. Of all-metal construction, the F.13 was a four-passenger monoplane in a biplane era. And unlike converted bombers, it was designed for passenger service from the start. More than 300 were built. Leadership then moved to the United States, with the pathbreaking work of William Stout and then the Ford Motor Company with its famous 1926 Tri-Motor, an all-metal aircraft with substantial load capabilities and steady flying characteristics. Nearly 200 were made before production ceased in 1932; there was even a bomber version, though it was not successful. The similar Junkers Ju 52/3m appeared the same year; thousands of copies of the German airliner were manufactured, half of them during World War II. Both of these aircraft emphasized reliability and strength over beauty.

The early 1930s saw a breakthrough when airliners' designs as well as airspeeds were far ahead of military aircraft. The value of streamlining was demonstrated with a number of handsome single-engine U.S. airliners built from 1927 through the 1930s. Northrop's Alpha (1930), Delta (1933), and Gamma (1932) aircraft represented one approach. The Lockheed single-engine airliners—the Vega, Sirius, Altair, and Orion series—were even better known and used by several airlines.

Boeing manufactured the first modern twin-engine airliner, the Model 247, in 1933. This plane was far ahead of its civilian rivals, let alone any military aircraft. Lockheed's twin-engine Electra series (the L-10 first flew in 1934) expanded the lead, figuring in important long-distance flying feats, including Amelia Earhart's and Howard Hughes's around-the-world flights. Refined L-14 (1937) and L-18 Lodestar (1938) models served in a variety of airline and then military roles in the 1940s.

Britain's Imperial Airways lagged with lumbering biplanes until the handsome S.23 C-class all-metal Empire flying boats of 1936, which opened many routes to British colonies in Africa and Asia. The design led directly to the wartime Sunderland naval patrol boat.

The ultimate airliner of the period—the Douglas DC-2/3 series—was an established standard around the world by 1941. At the same time, most military aircraft were aging biplanes. The developing DC-4 and Constellation four-engine airliners demonstrated that the military could rely on civil designs for military air transport. And so they did until after World War II, when purpose-built military transport designs became important.

British, French, and Dutch airlines pioneered service into and across Africa and Asia in the 1930s, developing needed airports, hot-and-high take-off procedures, means of navigation in regions with little infrastructure, and regular schedules for people, mail, and some freight over long distances. Their airliners, at first biplanes of marginal reliability but soon all-metal aircraft with vastly improved range and carrying capacity, paved the way for wartime military routes.

U.S., British, and German efforts to span the all-important Atlantic barrier likewise developed the expertise needed for wartime ferry flights and postwar airline use. U.S. and British efforts focused on long-range flying boats, with the inception of regular (and highly expensive) passenger flights in mid-1939. The 1937 Focke-Wulf Fw 200 Condor was the first four-engine landplane to fly the Atlantic (in 1938) and also tested a Lufthansa route to Tokyo. Only briefly in airline service, the handsome aircraft could fly better than 200 mph, faster and farther than most military planes of that time.

Likewise, Pan American's transpacific flights of the late 1930s helped pave the way for regular military transoceanic transport flights during the war. The ever-larger and more capable Sikorsky S.42 (1934), Martin 130 (1935), and Boeing 314 (1938) flying boats were far beyond anything operated by the U.S. and most foreign military services. Although none directly led to military models, the techniques and procedures used to fly them long distances were of immense wartime value.

Christopher H. Sterling

See also

Civil Aviation: Impact of Military Advances

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Civil War (U.S.) and Use of Balloons

The first use of airpower for military purposes in the United States occurred in the Civil War. Union and Confederate forces used balloons for a variety of purposes such as artillery spotting, observing troop movements, estimating enemy strength, and observing construction of fortifications.

The Union Army organized a balloon department led by civilians from August 1861 through July 1863. It had seven balloons under the control of Thaddeus Lowe and two under John LaMountain. Lowe and LaMountain were bitter rivals and never joined forces. Lowe employed notable aeronauts of the day such as John H. Steiner, Ebenezer Seaver Jr., James Allen, Ezra Allen, and John B. Starkweather; LaMountain operated as a solo aeronaut. Both balloon teams used military troops who were detailed from the closest corps to where the balloons were stationed. These troops supported balloon maintenance and operations. Approximately 30 men were used to operate each balloon. By the end of the war, more than 300 troops had been trained to support the balloons.

Lowe was an inventive genius. He developed a system of successful telegraph operations from his tethered balloons. He conceived and constructed the first specifically designed flat-top aircraft carrier, called the *G. W. Park Custis,* and at least twelve portable gas generators that were used in the field and on the *Park Custis.* Lowe would launch a tethered balloon from the carrier, which was originally a coal barge, and had it towed up and down the Potomac, James, and York Rivers, allowing observations of the enemy from a mobile platform.

Operationally, the Union balloons did not use hot air, but hydrogen or city utility gas. The balloons were deployed at a variety of strategic locations, ascending to heights of about 1,000 feet and tethered to the ground in order to make observations lasting many hours. More than 3,000 flights were made in this manner. Union balloons were used extensively around Washington, D.C., in the Peninsula Campaign right after Antietam, and at the Battles of Fredericksburg, Chancellorsville, and Island No. 10.

Although LaMountain would mostly make observations from a tethered balloon, he occasionally performed a number of sensational "free" (untethered) flights over Confederate positions, relying on oppositely directed wind currents at different layers of the atmosphere to bring his balloon back to the Union lines. LaMountain is also credited with the first tethered balloon observations from a moving steamer around Fortress Monroe, Virginia.

The Confederates would occasionally operate a few balloons but never established an infrastructure to support them. It is believed that they did not use professional balloonists but pressed into service novices such as John Randolph Bryan and Potter Alexander. Confederate ballooning was performed largely in response to the Union effort.

James L. Green

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Civil Wars

A domestic conflict between military forces of the same state or political entity is known as a civil war. Airpower has played an important role in civil war, beginning in the nineteenth century. There have been roughly 40 intrastate, political, secessionist, or ethnic conflicts in which airpower was employed. Airpower, since its introduction into warfare, has emerged as an integral and decisive part of these conflicts and has been employed in diverse strategic, climatic, and terrain conditions. Additionally, the air dimension of civil wars stimulated or emphasized some significant changes in air technology, organization, strategy, and tactics.

In 1849, Austrian troops unsuccessfully experimented with the balloon bombing of the rebellious Venetians. Balloons were also used in 1862 during the U.S. Civil War, where Union and Confederate forces used balloons for a variety of purposes: artillery spotting, observing troop movements, estimating enemy strength, and observing construction of fortifications. During the war in France in 1871, the Commune of Paris tried to use balloons for reconnaissance and propaganda purposes.

In most civil wars during the first half of the twentieth century, government troops and foreign interventionist forces employed airpower for machine-gunning, bombing attacks, and reconnaissance.

In some important cases, domestic antagonists used aircraft for air-to-air combat (Russia in 1918–1920, China in the 1920s, Spain in 1936–1939). Civil wars also emphasized the critical importance of air dominance and developed sophisticated air operations. Examples of this include the use of railroads for massive transport of air units and strategic maneuver between the fronts; combined operations, including seaplane support to ground troops (Russia); air strikes on naval targets and the dissemination of propaganda by air (Russia, Spain); and interdiction of enemy supply lines (Spain).

The second half of the twentieth century witnessed large-scale employment of airpower in civil conflicts. These include China in 1945–1949; Congo/Katanga in 1960–1967; Ethiopia/Eritrea in 1961–1991; Iraq/Kurdistan since 1963; Rhodesia in 1965–1980; Nigeria/Biafra in 1967–1970; Angola and Mozambique in 1975–1991; and elsewhere.

The guerrilla nature of many civil wars made helicopters with light automatic weapons and grenades a useful tool for attacking rebel formations. The guerrillas in turn developed a new generation of antiaircraft weapons, especially surface-to-air missiles.

The historical and military experience of air operations in civil wars saw significant developments, including massive airlift of troops, weapons, and supplies (China); the first use of air-to-air guided weapons during the 1958 air battles between communist and Nationalist Chinese aircraft (Taiwan Strait); the introduction of mixed antiguerrilla fire forces with the extensive use of antipersonnel bombs (Rhodesia); the use of chemical weapons by government air forces (Iraq/Kurdistan; Laos since 1975); the rise of helicopter gunships to a dominant role in air operations (Angola, Mozambique, Sri Lanka, Nicaragua, and El Salvador); and the use of aircraft for large-scale refugee movements (Biafra).

Since the use of aircraft during the U.S. expeditions into Mexico in 1914–1916, foreign airpower interventions have been an important pattern of civil wars. There were many decisive and crucial air interventions by third parties in civil wars: the Italians, Germans, and Soviets in Spain in 1936–1939; the RAF in Greece in 1944–1949; the French in Chad in 1983–1984; the Turks in Cyprus in 1974; and India in Sri Lanka in 1987–1990.

Additionally, some interventions of the twentieth century demonstrated important operational and tactical decisions in the use of airpower. These include the first air operation in support of naval attack (U.S. flying boats for mine searching in Vera Cruz, Mexico, 1914); the first combined air-naval operation (the Allied seizure of Archangel, Russia, 1918); the first successful dive-bombing (U.S. Marines in Nicaragua, 1927); the first massive and decisive airlift of troops (Germans into Spain, 1936); the first decisive airborne assault in civil war (U.S.-Belgian rescue operation in Congo, 1964); and the use of gas attacks (Egyptian intervention in Yemen, 1962–1970).

Some foreign military interventions in civil wars, involving large-scale use of airpower, evolved into major local wars, as with U.S. involvement in Vietnam and the Soviet intervention in Afghanistan.

Peter Rainow

See also

Chinese Communist Air Force; Counterinsurgency Operations; Gunships; Helicopters, Military Use; Somalia; Soviet Air Force; Spanish Civil War

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Clark, Joseph J. "Jocko" (1893–1971)

World War II aircraft carrier commander and Korean War fleet commander. Clark was born in Pryor, Oklahoma, on 12 November 1893 and attended the U.S. Naval Academy, graduating in 1917 with the original class of 1918. His career followed the standard path; he served on destroyers, saw convoy duty at the end of World War I, and commanded USS *Bulmer.* Clark volunteered for flight training, becoming a naval aviator in 1925. He commanded Fighting Squadron 2-B, embarked on USS *Lexington,* served as *Lexington*'s air officer from 1936 to 1937, commanded Patrol Wing Two, and was executive officer of USS *Yorktown.* Following the outbreak of war with Japan, he quickly gained tactical experience in carrier warfare. In 1943, Clark became the first commanding officer of the new *Yorktown.* He subsequently led carrier formations around Saipan, Iwo Jima, and Okinawa.

In 1946, Clark became assistant Chief of Naval Operations (Air). He next commanded Carrier Division Four, his post at the outbreak of the Korean War. He led Task Force 77 during initial combat operations and subsequently headed naval air bases (Eleventh and Twelfth Naval Divisions), as well as Carrier Division Three. In 1952, he was promoted to vice admiral, became commander of First Fleet, and almost immediately moved to command of Seventh Fleet.

Clark worked closely with his Air Force counterpart, Lieutenant General Glenn Barcus, integrating naval aviation into the overall air campaign. Offensively oriented, Clark took the war to his land-based enemy whenever possible, winning the trust of United Nations Commander General Mark Clark. He later successfully shifted the focus of naval air strikes to interdict communist supply lines.

Clark was promoted to full admiral upon retirement from active duty in 1953. Following a career in the corporate world, Clark died in St. Albans, New York, on 13 July 1971.

Michael S. Casey

See also

Iwo Jima; Korean War; Okinawa; STRANGLE

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Clark, Mark W. (1896–1984)

U.S. Army general; liberated Rome during World War II and terminated the war in Korea. Also a strong advocate of large-scale use of airpower in support of ground operations.

Mark Clark was born in Watertown, New York, on 1 May 1896. After graduating from West Point in April 1917, he served in France as commander of an infantry company and then a battalion. After World War I, he took various army assignments, attended the Fort Leavenworth Command and General Staff College (1933) and Army War College (1936), and was promoted to commander, 3d Infantry Division. Clark obtained the reputation as an extremely effective trainer of his troops, conducting exercises in realistic and innovative manner.

In 1942, General Clark was appointed commander of the U.S. II Corps in England. He contributed enormously to the success of Operation TORCH in 1942 as one of its main planners and as the chief Allied negotiator with the Vichy administration in Algeria.

As a commander of the U.S. Fifth Army and later the Fifteenth Army Group in Italy, Lieutenant General Clark skillfully managed the multinational military formations and provided effective interservice coordination, including employment of airpower for isolating the battlefield. Winston Churchill was deeply impressed by Clark's command ability and called him "the American Eagle."

At the same time, Clark's attempt to reach Rome by frontal advance led to the bitterly fought Battle of Monte Cassino (January-May 1944) and destruction of its medieval monastery by massive bombing. Although demonstrating the spectacular power of strategic bombing, this action's operational effect was limited and remains a matter of controversy.

After World War II, Clark took several command positions: commander of U.S. troops in Austria (1945–1947), commander of the U.S. Sixth Army (1947–1949), and chief of Army field forces (1949–1952). During the Korean War, Clark supported the idea of retaliatory bombing of military targets in Manchuria and China. In 1952, he was appointed commander in chief of U.S. troops in the Far East as well as UN troops in Korea. Clark undertook a bombing campaign to regain success on the ground and bring about the ceasefire with the North Koreans and the Chinese.

After the war, Major General Clark served as president of the Citadel in Charleston, South Carolina (1954–1965); he retired from the Army in 1965. During the Vietnam War, he supported President Richard Nixon's decision to resume the air campaign over North Vietnam. Clark died in Charleston on 17 April 1984.

Peter Rainow

See also

Anzio, Battle of; Cassino, Battle of; Italian Campaign; Korean War

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Clark, Wesley K. (1944–)

U.S. Army general. Wesley K. Clark was born in Little Rock, Arkansas, on 23 December 1944. A 1966 graduate from the U.S. Military Academy at West Point and career armor officer, Clark made his greatest contribution to airpower history as Supreme Allied Commander Europe during the bombing of Yugoslavia by the North Atlantic Treaty Organization (NATO) in Operation ALLIED FORCE (23 March–9 June 1999).

Clark's rise to prominence in U.S. policy regarding the former Yugoslavia stems from his involvement in the 1995 Dayton Peace Accord. At Dayton, Clark forged relationships with many of the leaders of Yugoslavia, whom he would go to war against during ALLIED FORCE in 1999. Clark believed he had a special insight into the mindset of Yugoslav President Slobodan Milosevic, which influenced his employment of airpower in ALLIED FORCE.

During ALLIED FORCE, Clark found himself at odds with his Allied Air Forces Southern Europe commander, U.S. Air Force Lieutenant General Michael C. Short, who was in direct command of ALLIED FORCE air operations. Short, who also had met with Milosevic on several occasions, wanted an air campaign that would inflict massive damage on the Yugoslav hierarchy and infrastructure, compelling the Yugoslav government to sue for peace in Kosovo. Clark, by contrast, feared a strategic bombardment would bring world condemnation and unravel the fragile NATO coalition. Instead, he believed that the Yugoslav Third Army in Kosovo was the true center of gravity in the conflict and demanded interdiction strikes against fielded forces as well as close air support for Kosovo Liberation Army rebels. This disagreement in strategy led to much verbal sparring between Clark and Short throughout the conflict, as well as a campaign strategy that seemed to wander from one objective to the next for the entire 78-day effort.

In the aftermath of ALLIED FORCE, both Clark and Short would claim their strategy was the one most responsible for Milosevic's capitulation to NATO demands. Short claimed the attacks on key Yugoslav government buildings and the electric power grid ended the war. Clark, ever the Army officer, credited the show of NATO will for the victory. To Clark, bombing the Yugoslav Third Army and threatening a ground invasion of Serbia convinced Milosevic he could not prevail. In the end, ALLIED FORCE would become the final accomplishment in the military careers of both men.

Mark D. Witzel

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Clay, Lucius D. (1897–1978)

U.S. Army general who served as military governor of occupied Germany and directed the Berlin Airlift in 1948–1949. Born on 23 April 1897 in Marietta, Georgia, Clay graduated from the U.S. Military Academy in 1918. He served in Army engineer assignments before becoming head of the first national civil airport program (1940–1941). Soon after the U.S. entered World War II, he became a specialist in war production and supply and in 1942 was placed in charge of the Army procurement program.

When the war was over, Clay became the deputy military governor in Germany under General Dwight D. Eisenhower. Two years later, he was elevated to commander in chief of U.S. forces in Europe and military governor of the U.S. Zone. As such he had to direct the support for a devastated civilian population and, simultaneously, supervise a denazification and deindustrialization. In 1948, when the Soviets blockaded Berlin, Clay directed a successful Allied airlift of food and supplies into the city.

Following his retirement in May 1949, Clay entered private business and became active in politics as a supporter and adviser to President Eisenhower (1953–1961). In 1961 and 1962, President John F. Kennedy asked Clay to serve as his personal representative in Berlin, with the rank of ambassador, to help deal with the critical situation that had developed among the four occupying powers concerning that city's future status. Clay died on 16 April 1978 in Cape Cod, Massachusetts.

James H. Willbanks

See also

Berlin Airlift

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Close Air Support

Air attacks conducted in support of friendly ground forces, normally when directly engaged with enemy surface forces. Close air support (CAS) operations emerged during World War I as pilots sought to use the advantage of altitude to identify and attack enemy forces and key positions. Attacks were initially conducted with machine guns, eventually termed "strafing," and by dropping a variety of explosive devices such as grenades, modified artillery shells, and eventually specially designed bombs.

Initially, armed observation and fighter aircraft performed ground attack missions. With experience, the air forces developed specialized ground attack aircraft, normally characterized by protective armor, multiple machine guns, and the ability to drop bombs. All sides in World War I recognized the value of using the speed and flexibility of airpower to provide timely, powerful, concentrated attacks against enemy ground forces, with special appreciation for the psychological effects on troops subjected to heavy air attacks. The close-attack aviation experience during World War I identified the major challenges for this type of mission. Night and poor weather conditions severely limited operations; enemy air defenses were especially intense at the front lines; command and communications systems were needed to quickly identify the most appropriate targets and to task attack aircraft for timely missions; and distinguishing between friendly and enemy forces was often difficult, especially in fluid tactical situations.

CAS concepts and capabilities evolved significantly during the interwar period and were further improved during World War II. CAS developments during the interwar period were strongest in those militaries that were creating mechanized ground forces that required mobile and flexible sources of firepower, such as the German army and Luftwaffe team or the Red Army and Red Air Force team in the Soviet Union. CAS capabilities were also important for light forces that did not have significant assigned firepower resources, such as the U.S. Marine Corps or British units controlling the extensive empire.

Although existing fighter designs were used extensively for ground attack missions during this period, air forces also developed specialized attack aircraft—such as dive-bombers—and developed tactics and procedures for the use of light and medium bombers in direct support missions. Combat operations during World War II provided the refining experience for CAS, with the Luftwaffe demonstrating considerable skill and success early in the war; British and American tactical air forces, as well as the Russian Frontal Aviation forces, developed significant capabilities as the war progressed. These wartime developments included improved aircraft performance—both in multirole fighters and specialized attack aircraft—and new munitions, such as cannons and high-velocity rockets.

However, the most significant developments were the evolution of effective air-ground organizations for improved planning and coordination and the creation of effective communications systems for command and control of attack missions. Control of air strikes also was improved by assigning trained observers (often pilots) equipped with tactical radios to front-line combat units to direct attack aircraft. These observers, known as forward air controllers (FACs), helped the attack pilots identify targets and ensured that the location of friendly units was clearly established before weapons were delivered. In Korea, Vietnam, and Operation DESERT STORM, the U.S. military built on the experience of World War II, adding the use of airborne FACs to improve flexibility and to enhance the effectiveness of air attacks. After Korea, the U.S. Army, as well as many other military forces, developed specialized attack helicopters that provided a responsive close-attack capability that was normally assigned directly to the ground commander as a firepower resource.

Technological developments also significantly improved CAS capabilities in the late twentieth century, including the use of improved navigation systems, marking beacons to identify friendly and enemy locations, enhanced communications systems, laser designators, and other guidance systems that allowed precise weapons delivery close to friendly forces.

CAS operations often have been the focus of significant interservice disagreement over the allocation of airpower in combat. After air superiority, ground force personnel tend to view CAS—attacks on the most immediate threat—as the best use for airpower. Air Force leaders accept the value of CAS, especially in emergencies or in fluid offensive operations, but tend to believe that other uses of scarce air assets, especially air superiority, interdiction, or strategic attack missions, are more effective in accomplishing the strategic and operational (i.e., theater) objectives. Senior air commanders often argue that deeper missions can have a greater impact on theater operations by destroying enemy forces and supplies before they can engage or maneuver against friendly forces. Additionally, enemy forces and supplies will normally be more vulnerable to attack and less protected in the rear, and enemy resources devoted to protecting the rear area will further reduce the combat potential at the front. Deep air operations also avoid the heavier defenses on the front, reduce the complex coordination requirements with friendly ground forces, and eliminate the potential for fratricide (inflicting damage and casualties on friendly forces). To reduce fratricide and control concerns, some military forces developed ground support tactics that attacked the enemy slightly behind the line of contact, often assigning another mission title, such as battlefield air interdiction.

CAS operations can be highly structured, preplanned attacks, or they can be responsive to a changing tactical situation from ground or airborne alert positions. CAS missions must be tightly controlled and well integrated into the ground force commander's scheme of maneuver and fire-support plan, and a strong command and control system is necessary for effective CAS operations.

Jerome V. Martin

See also

Air Interdiction; Defense Suppression; Frontal Aviation; German Air Force (Luftwaffe); Tactical Air Warfare

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Cold War

Tense standoff between the two global superpowers in the East (Soviet Union) and West (United States) that lasted some 45 years after World War II until the collapse of communism. Airpower played a critical role in the Cold War. When the specter of global thermonuclear war dominated military planning for a half-century, aviation provided the primary means of nuclear attack and defense. The skies were also the most frequent arena for direct military clashes between the superpowers and their allies. Given that the Cold War was as much about economic competition and international prestige as purely military concerns, the importance of airpower in operations other than war is too often overlooked.

Atomic warfare was associated with aviation from the very beginning. The first and last nuclear weapons ever used in anger were dropped by U.S. B-29 bombers in August 1945 on the Japanese cities of Hiroshima and Nagasaki. These actions represented the end of World War II (Japan soon surrendered) and the beginning of the Cold War (erstwhile allies aligned against one another). As postwar tensions mounted, the United States clung to its monopoly on atomic weapons as its trump card in any future conflict. In the late 1940s and early 1950s, the U.S. Air Force developed the newly created Strategic Air Command into an elite force of medium- and long-range bombers capable of delivering nuclear weapons to targets throughout the Soviet Union, a strategy of massive retaliation in the event of war with the communist nation. Though the Soviet Union tested its first atomic bomb in 1949—years earlier than expected—the United States remained well ahead in its capacity for nuclear attack throughout the 1950s. In the early 1950s, the superpowers added thermonuclear weapons to their arsenals; some explosive yields were 1,000 times more powerful than early atomic bombs. By the mid-1950s, it had become possible to kill an entire nation in a matter of days. U.S. military planners hoped their nuclear superiority would deter any war, but should it come they continued to believe they could "win" a nuclear exchange by undertaking a massive first strike, thereby preventing Soviet retaliation. These hopes began to fade following the first Soviet tests of intercontinental ballistic missiles in August 1957 and the subsequent deployment by both sides of an increasing number of nuclear-tipped ICBMs and submarine-launched ballistic missiles. By the mid-1960s, U.S. nuclear theorists, recognizing that a global nuclear war would mean the obliteration of both protagonists, dubbed this strategy one of mutual assured destruction (known by its apt acronym MAD). It was now possible to kill an entire nation in a matter of hours.

Though neither side gave up trying to develop antimissile defenses capable of hitting a bullet with a bullet (i.e., intercepting incoming ICBMs), the problem was never solved. The resulting nuclear danger posed to the U.S. and Soviet homelands provided the single greatest deterrent against the Cold War becoming "hot." Because the bomber (or at least missiles) would always get through, airpower played a critical role in deterring World War III.

The absence of global war did not mean, however, that there were no direct and violent interactions between the armed forces and intelligence services of the superpowers. Early in the Cold War, incidents most often took the form of Soviet attacks on U.S. and British aircraft as they gathered intelligence by flying near, and sometimes over, Soviet airspace. By far the most famous incident was the May 1960 downing of a U-2 spyplane piloted by Francis Gary Powers, but this was not the only incident. By one count, 40 U.S. aircraft were shot down by Soviet and their allies' aircraft between 1947 and 1977, most while on intelligence-gathering Ferret flights. Of the 356 men involved in these 40 flights, 187 survived, 34 bodies were returned to the United States, and the fate of 135 remains unknown. There is evidence that some were captured alive. Another indication of the scope of these missions comes from the secretive U.S. National Security Agency, which stated in one of its few official publications, an eight-page pamphlet entitled "Dedication and Sacrifice," that 152 cryptologists lost their lives during the Cold War, 64 of them while engaged in aerial reconnaissance.

Direct conflict also took place during wars fought by one superpower against a proxy of the other. During the Korean War, for example, Soviet pilots, flying their own aircraft in Chinese markings, battled U.S. fighters over North Korea, a fact reportedly known to the United States through signals intercepts. Some captured U.S. pilots were probably taken to China and the Soviet Union for interrogation and never returned. By the late 1960s during the Vietnam War, there were more than 1,000 Soviet military technicians in North Vietnam maintaining and operating surface-to-air missile sites against U.S. aircraft. Similarly, though on a smaller scale, U.S. CIA officers in the 1980s delivered surface-to-air Stinger missiles to Afghan mujahideen rebels, trained them in their use, and at least once traveled with them inside Afghanistan and pointed out Soviet Hind helicopters to be shot down. And in 2001, U.S. aircraft faced the possibility of taking fire from U.S.-provided weapons in air strikes against Afghanistan.

Given the secrecy that continues to surround these Cold War encounters, the full truth may never be known.

Finally, since its inception aviation has held a certain mystique, especially within the Soviet Union (now Russia) and the United States. Given that the Cold War was as much a struggle over hearts and minds as it was about weapons and territory, airpower naturally was caught up in the competition. When the Soviet Union cut off ground access to West Berlin in the summer of 1948, it was the symbolism of benign Western technology feeding a hungry city for an entire year through airpower alone that made the Berlin Airlift such a devastating propaganda defeat for the Soviet Union. It is hard to appear to the world as the good guy when a nation finds itself literally lodging diplomatic protests objecting to the dropping of candy to children (over East Berlin); it is no coincidence that the symbolic end of the Cold War is generally taken to be the scene of Berliners (East and West) dancing together on the Berlin Wall in November 1989.

The superpowers and their allies also raced to claim various aeronautical records, such as the breaking of the sound barrier by a U.S. X-1 in October 1947 and the Soviet deployment of the world's first supersonic airliner, the ill-fated Tu-144, which first exceeded the speed of sound in June 1969. (In keeping with the Cold War motif, the design of the Tu-144 owed much to the illicit acquisition by Soviet intelligence agents of blueprints for the Franco-British Concorde; and the famous June 1973 crash of a Tu-144 at the Paris Air Show was due in large part to a bungled French attempt to have a Mirage fighter clandestinely photograph the Soviet jet in midflight.) The competition in space was even more intense, with the Soviet Union placing into orbit the first satellite (Sputnik, October 1957) and the first human (Yuri Gagarin, April 1961), and the United States winning the race to the moon (July 1969). Even such scientific achievements were offshoots of military projects, especially the desire of both sides to deploy the first ICBMs (the Soviet R-7 series) and the first spy satellites (the U.S. CORONA satellites). It is a fitting symbol of the post–Cold War era that at the turn of the century the largest project in aerospace exploration would be the International Space Station, the two primary sponsors being Russia and the United States. The countries continue to bicker, and Russia continues to play the poor cousin, but the end of the Cold War—as well as the disruption caused by unexpected world events—have led to more cooperative efforts.

David Rezelman

See also

Air Defense Command; Antimissile Defense; Atomic Bomb; Cold War, and Commercial Aviation; CORONA Spy Satellites; Cuban Missile Crisis; Electronic Warfare; Ferrets; Korean War; LeMay, Curtis E.; Massive Retaliation; Mutual Assured Destruction; National Security Council; North American Air Defense Command; North Atlantic Treaty Organization; Powers, Francis Gary; Satellites; Single Integrated Operational Plan; Soviet Air Force; Space Stations; Sputnik; Strategic Air Command; Strategic Arms Limitation Talks; Strategic Arms Reduction Talks; Strategic Defense Initiative; Suez Crisis; Tactical Air Command; Vietnam War; Warning Systems

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Cold War and Commercial Aviation

The Cold War dramatically affected international commercial aviation, as governments on both sides of the Iron Curtain agreed on the desirability of limiting East-West travel and contact. Washington made denying communist access to Western travel networks an essential part of its doctrine of containment, fearing Soviet leaders would pervert aviation's benefits: Aircraft intended to bring people closer could simultaneously transport communist spies; technologies necessary for air transit could enhance communist military capabilities; and communist airlines "showing the flag" around the world could enhance communist prestige abroad.

This air-containment philosophy was codified in 1948 with National Security Council Resolution 15 (NSC-15), which cut off American air ties to communist states. Soviet officials, eager on their own to limit Western access to Eastern Bloc countries, agreed with Washington's goals if not its underlying motives. Limits imposed in Washington and Moscow only retarded East-West travel, however, as other countries, especially those on the Cold War's dividing lines, hesitated to enforce such harsh restrictions. East-West transit remained a difficult but feasible option for travelers willing to fly through neutral or less belligerent states. Faced with détente and the growing conviction that travel could improve East-West ties, Washington approved direct flights from America to Eastern Europe in the late 1960s and to mainland China in the 1970s, though American flights to Cuba remained banned well after the fall of the Berlin Wall.

The bipolar conflict also altered international aircraft sales and development, as NSC-15 additionally barred the export of Western commercial aircraft to communist states. Washington sought to limit communist access to aeronautical technologies present on civil airliners, since most technical advances in commercial aviation began as military projects. Indeed, military procurements were crucial to the dramatic strides made by commercial aviation during these decades. For example, Britain's first jet airliner, the Comet, carried engines developed for bombers, and Boeing's 707 developed from production of an Air Force tanker, the KC-135. Air-traffic control technologies also gained immeasurably from Pentagon-funded research in electronics, computers, and radar systems. America's allies once more took a less rigid stance than Washington, however, and in 1958 Great Britain began exporting aircraft across the Iron Curtain. France soon followed, and by the mid-1960s even U.S. firms could sell in Eastern Europe; China remained off-limits until 1972. By the 1970s, détente eased travel and business between the Cold War's belligerents.

Jeffrey Engel

College Eye Task Force (CETF)

Airborne radar platforms sent to Southeast Asia in April 1965 by the U.S. Joint Chiefs of Staff. Once the decision was made, the 552d Airborne Early Warning and Control Wing provided five EC-121Ds with VHF voice capability, crews, and some 100 support personnel. This detachment, initially known as the Big Eye Task Force, was rechristened the College Eye Task Force in July 1967.

CETF's main support base was in Taiwan, with a forward operating base initially at Tan Son Nhut in South Vietnam and, later, at Thailand bases in Ubon, Udorn, and Korat. CETF aircraft over the Gulf of Tonkin controlled airstrikes against North Vietnam, relayed information between strike aircraft and Seventh Air Force headquarters, warned of enemy fighter activity, vectored friendly interceptors, helped friendly aircraft find tankers, and assisted in search-and-rescue operations. CETF aircraft over Laos prevented friendly aircraft from violating Chinese airspace and directed strike, escort, and combat air patrols on the border between North Vietnam and Laos.

EC-121Ds carried 6 tons of surveillance equipment and a crew of 31. The twin radomes on the aircraft fuselage could sweep a 40,000-square-mile area. The radar could not, however, "look down" over land, because ground clutter obscured radar returns.

From 1965 to 1973, CETF EC-121Ds flew 13,921 combat missions (for 98,777 combat hours). Aircraft were on station 24 hours a day every day and assisted more than 135,000 fighters and bombers to reach their targets and return. CETF was credited with 25 MiG kill assists, the first in July 1965. CETF participated in the successful rescue of 80 downed aircrew members. CETF was sometimes able to place rescue aircraft over downed aircrews before they even reached the ground. CETF also prevented 3,297 friendly aircraft from violating Chinese airspace. CETF flew its last combat mission on 15 August 1973 and deactivated for return to McClellan AFB in June 1974.

James D. Perry

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Colonial Wars

Military force, especially airpower, was used by colonial powers to conquer, dominate, and preserve control over their territories despite resistance and struggle for independence by local populations. There were some 40 wars, conflicts, and military actions of this kind in the twentieth century. The most distinctive feature was their one-sided character: the indisputable air dominance of colonial powers. In the two exceptions (the Italo-Ethiopian War of 1935–1936 and the First Chechen War of 1994–1996), the European powers rapidly and decisively eliminated their potential air opponents.

The colonial experience also had a significant influence on technological development, organizational evolution, and expansion of major world air forces as independent services, as well as their air doctrines, combat performances, tactics, and operations.

The first recorded attempt to use airpower in colonial conflicts was by Napoleon in Egypt in 1799, with he used balloons to undermine the morale of the hostile population. Britain and Spain also used balloons in military campaigns in Africa in the late nineteenth and early twentieth centuries.

Aircraft surpassed balloons as an instrument of colonial control. As opposing forces usually lacked any air force, reconnaissance and ground strafing were the primary tactics. However, some expeditions introduced important operational and tactical novelties to the air warfare. These include aerial bombing (the Italian war in Tripolitania, 1911; the French campaign in Morocco, 1912–1914); casualty evacuation (U.S. Marines occupation of Haiti, 1915–1924); evacuation of populations (RAF action in Kirkuk, Mesopotamia, 1924); and combined use of airpower and mechanized units, as well as gas attacks (the Italian war in Abyssinia, 1935–1936).

Aerial bombing, ground support, and reconnaissance were used extensively during the British war in Afghanistan in 1919, the Spanish and French campaigns against the Rifs in Morocco in 1919–1926, the Soviet operations against Muslim rebels in Central Asia in 1920–1933, and the Italian expeditions in Libya and Italian Somaliland during the 1920s.

Colonial wars also stimulated the development of multipurpose aircraft (bomber/transport/reconnaissance) as well as general-purpose planes. The colonial experience, as well as the effectiveness of airpower over costly ground expeditions, propelled the emergence and development of the most important contribution of colonial air operations to the history of airpower: the theory and practice of an air constabulary and aerial policing.

The Royal Air Force invented this new function and was successful in performing air raids, support, communications, air cover, and evacuation in Iraq, British Somaliland, Aden, Sudan, India's Northwest Frontier, Palestine, and Transjordan during the 1920s–1930s. These demonstrated the RAF's ability to control disturbances, tribal warfare, and border disputes and proved its effectiveness in garrisoning the empire—and thereby proved its own indispensability as an autonomous and unified service.

After World War II, the overall strategic pattern of colonial air warfare had changed dramatically. Although the Western colonial powers enjoyed improvements and innovations in air technology (jets, helicopters, power projection, and airlift capacity), they remained dependent on U.S. military and financial aid and logistic support.

Nationalist forces challenged European air superiority with antiaircraft weapons from their new communist patrons and Third World allies. An active air strike on rebel external bases and supply lines usually led to the internationalization of colonial war and further isolated the colonial power. No example could better serve as a symbol of this radical shift in the balance of power than the 1961 conflict in Portuguese Goa, when the oldest colonial army in the world was swiftly overwhelmed by Indian air assaults.

In addition to traditional functions (bombing raids, reconnaissance, troop transport, search and rescue), the use of airpower in colonial wars of 1945–1974 demonstrated some operational and tactical innovations. These included large-scale aircraft carrier assaults (the French in Indochina, 1947–1954; the British in Malaya, 1948–1960 and South Arabia, 1958–1963); the first operational use of helicopters for casualty evacuation (Malaya, 1950); the largest airlift since Berlin (the British evacuation from Aden in 1967); the first large-scale combat use of helicopters (French in Algeria, 1954–1962); large-scale decentralization of air operations control (Malaya, Algeria); use of air chemical attacks to eliminate jungle cover for rebels (Malaya) and food resources for insurgents (the Portuguese in Mozambique, 1961–1974); and psychological warfare (Malaya, Indochina).

Although the introduction of helicopters and improvements in air mobility led mostly to success in counterinsurgency in colonial and dependent territories, they could not change the unfavorable pattern of rising nationalism and decolonization. Neither could they provide an answer to the growing urban guerrilla and terrorist operations, which developed into a dominant feature of irregular warfare, as the Russian air campaign in Chechnya in 1994–1996 demonstrated. The use of airpower against terrorist elements in the harshest conditions was again put to the test in 2001 during the U.S. air strikes against Afghanistan.

Peter Rainow

See also

Algeria; Churchill, Winston; Counterinsurgency Operations; Ethiopian War; French Air Force; French Army Light Air Force; French Naval Air Force; Gunships; Helicopters, Military Use; Parachutes; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Russian Air Force (Post-Soviet)

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Combat Cargo Command

U.S. Air Force airlift organization at the beginning of the Korean War. Combat Cargo Command was formed on 10 September 1950 as a response to theater airlift requirements in the Far East that were created by the Korean War. Led by airlift specialist Major General William H. Tunner, the new organization assumed operational control of all troop carrier assets in the theater. Tunner quickly brought centralized direction and standardized procedures to the airlift, replacing the earlier ad hoc arrangements. As a result, efficiency shot up.

Combat Cargo supported General Douglas MacArthur's landing at Inchon on 15 September 1950, flying urgently needed cargo into Seoul's Kimpo airfield only hours after its capture. Tunner's airmen then played a key logistical role in sustaining the Eighth Army's northward drive toward the Yalu River, including the airdrop of the 187th Regimental Combat Team near Pyyongyang in late October.

In late November 1950, the UN forces' advance turned into a retreat when massive Chinese forces entered the war. Combat Cargo was forced to conduct an airlift in reverse, flying out wounded soldiers and tons of materiel in the face of the rapid Chinese advance southward toward Seoul.

Combat Cargo was also called upon to sustain the beleaguered forces of X Corps in northeastern Korea. In some of the most challenging flying of the war, Combat Cargo's pilots air-dropped supplies to surrounded U.S. Marine Corps outposts adjacent to the Chosin Reservoir and evacuated wounded from tiny airstrips at Hagaru-ri and Koto-ri. At one point, the airlifters attracted national press attention in the United States when they air-dropped four sections of an M-2 treadway bridge to the Marines, enabling them to escape the Chinese trap with their heavy equipment intact.

In January 1951, as the military situation in Korea stabilized around the 38th Parallel, Combat Cargo Command, a temporary organization, turned over its airlift responsibilities to the 315th Air Division. It left behind an impressive record. In four and a half months, Tunner's airlifters had flown 32,632 sorties, carried more than 130,000 tons of cargo and 155,294 passengers, and were responsible for transporting 72,960 casualties to hospitals in Korea and Japan.

William M. Leary

See also
Airlift Operations, U.S.; Tunner, William H.

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Combat Search and Rescue (CSAR)

Known simply as "search and rescue" in the past, CSAR continued to be a key capability of U.S. air forces, special forces, and other services. General Henry H. "Hap" Arnold realized in World War II that the U.S. Army Air Forces needed to develop a capability to recover downed aircrews. This was based on two realities. First, training aircrews required a significant investment in terms of costs and time. And second, an expectation of recovery was key to the morale of the crews themselves. He directed the creation of rescue squadrons that had some success in both the Pacific and European theaters. Almost 5,000 men were rescued.

In the Korean War, helicopters were assigned to the rescue squadrons. Limited initially by range and load capability, these agile aircraft added a new dimension to rescue and made it theoretically possible to recover anyone from anywhere—including enemy-controlled territory. During this conflict, 340 American and Allied airmen were rescued, half of them from behind enemy lines.

During the Vietnam War, rescue capabilities continued to improve. New helicopters like the HH-53 were developed that had the range and load capability to rescue a downed airman from any part of that extensive theater. Additionally, task forces of supporting A-1 strike aircraft and forward air controllers were organized and perfected to locate downed airmen and protect the lumbering helicopters. In that long and bitter conflict, 3,883 airmen were recovered by the rescue forces.

In the 1991 Gulf War rescue duties were performed by specially modified helicopters of the Special Operations Command. During the seven-week campaign, there were three successful rescues from enemy territory. These efforts were duplicated in Bosnia during Operation ALLIED FORCE in 1999, when two downed American pilots were recovered again by helicopters of the Special Operations Command.

Today, every service has forces capable of rescuing American or Allied personnel from enemy territory. Every reasonable effort will be made to recover personnel who are at risk of capture.

Darrel Whitcomb

Combined Bomber Offensive

Allied bombing strategy in World War II. The Combined Bomber Offensive (CBO) is the term describing the strategy of nighttime area-bombing by the Royal Air Force combined with daytime precision bombing by the U.S. Army Air Forces in Europe in June 1943 to May 1944. The objective of this campaign was to destroy the German military, industrial, and economic systems and undermine the morale of its people.

The CBO was actually a strategy born of the opposing doctrines of the RAF and USAAF. The Americans, possessing many heavily armed "self-defending" long-range high-altitude B-17 and B-24 heavy bombers equipped with the extremely accurate Norden bombsight, had long advocated the concept of strategic bombing, or precision bombing of specified military targets.

RAF Bomber Command had quickly discovered that its lightly gunned and armored bombers were unable to fly daylight precision bombing raids without incurring unacceptably high losses. They were thus forced to revert to nighttime area-bombing, or blanket dropping of bombs over a broad target area. The round-the-clock bombing of Axis targets resulting from these combined bombing strategies became known as the CBO.

The CBO has generally been accepted as a successful campaign that achieved its objective; however, its true effectiveness and morality are still debated today. The *U.S. Strategic Bombing Survey* conducted at the end of the war showed a surprising lack of significant damage to heavily bombed German targets; furthermore, the Germans' will to fight was never shown to be significantly weakened by the bombing raids. In addition, the idea that mass formations of highly armed bombers were self-defending unfortunately proved to be a myth. Finally, even precision bombing in 1943–1944 was relatively indiscriminate, resulting in high numbers of German civilian casualties and destruction of cities.

Even so, there is little doubt that the CBO was the best strategy available at the time, a major contribution to the Allies' ultimate victory.

Steven A. Ruffin

See also
Casablanca Conference; U.S. Strategic Bombing Survey

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Command of the Air (Giulio Douhet, 1921)

Early airpower treatise promoted by Italian artillery officer Giulio Douhet (1869–1930). Douhet was one of the very first to think and write critically about the role of airpower in warfare. By 1915, the year Italy entered World War I, he had already formulated his theories, which included bombing campaigns directed against the morale of an enemy's population. However, his ideas were rejected; moreover, he was court-martialed and imprisoned for criticizing the Italian military's conduct of the war. He was eventually exonerated and promoted to general officer in 1921, the same year he published his most famous work, *Command of the Air.*

Making the assumption that future wars would be total and that defenses would never be capable of stopping a determined bomber offensive, *Command of the Air* advocated a national strategy relying upon control of the air to destroy an enemy's vital centers. In order to mount such an effort, air forces would have to be independent of ground and naval forces, and early airmen used Douhet's writing to argue for an independent air force. Although some of his predictions turned out to be incorrect, many of Douhet's principles proved timeless and, as such, are still seriously studied today.

Paul G. Gillespie

See also
U.S. Air Force Doctrine

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COMMANDO HUNT (1968–1972)

Code name for the quintessential aerial interdiction campaign of the Vietnam War. Operation COMMANDO HUNT lasted from 10 November 1968 until 10 May 1972 and involved seven distinct consecutive campaigns of six months' duration. It was aimed at cutting the Ho Chi Minh Trail, running some 250 miles through eastern Laos into South Vietnam and Cambodia.

COMMANDO HUNT involved attacks against four target categories. First there was the attack on trucks moving along the 200 miles of paved roads and hundreds of more miles of dirt roads. Gunships, including four-engine AC-130s armed with an array of 20mm Gatling guns, 40mm Bofors cannons, and, in later models, 105mm computer-aimed howitzers, emerged as the primary aircraft in the war on trucks. Second, bombers and fighter-bombers attacked the trail complex to include roads, pathways, waterways, repair depots, rest facilities, and storage areas. The trail complex was a logistical corridor that could handle an estimated 10,000 trucks at any one time.

A third aspect of COMMANDO HUNT was the attack on the terrain. Laser-guided bombs blasted the cliffs in Mu Gia, Ban Karai, and Nape Passes leading from North Vietnam into Laos in an attempt to cause landslides to close those roads. B-52 strikes, along with occasional C-123 Ranch Hand defoliation sorties, stripped away the jungle foliage. Bombs rained down on rivers and streams in an attempt to alter their courses. Fourth, there was the attack on the trail's defenses: the estimated 1,200 23mm, 37mm, 57mm and the occasional 85mm and 100mm radar-guided antiaircraft guns that blasted away at the attacking aircraft. Beginning in 1969, laser-guided bombs were first used to blast antiaircraft guns from the relative safety of 10,000 feet.

What made COMMANDO HUNT work was the Igloo White sensor system consisting of acoustical and seismic sensors dropped from aircraft and implanted in the ground and hanging from trees disguised as flora. Transmissions from the sensors were analyzed at a secret base known as Task Force Alpha (TFA) located on the Mekong River at Nakhon

Phanom Royal Thai Air Force Base, Thailand. At TFA, analysts developed targets and directed missions against all aspects of the trail as the attack continued day and night for nearly as long as ROLLING THUNDER.

In the end, the impact COMMANDO HUNT was difficult to estimate. Around 3 million tons of bombs and ordnance were expended, and many in the Air Force claimed it was another in an unbroken string of unmitigated airpower victories. Although many trucks were destroyed and the movement of supplies was by Vietnamese historians' own admission most difficult, the bombing never closed down the trail. In fact, North Vietnam moved the war from what was basically a guerrilla war to a conventional war in the period 1968–1972, culminating in a massive, 14-division offensive originating in Laos and Cambodia and out of the Central Highlands of South Vietnam, with most of those forces having traversed the Ho Chi Minh Trail.

Earl H. Tilford Jr.

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Commonwealth of Independent States (CIS)

Air forces of the former Soviet socialist republics, including Armenia, Azerbaidjan, Belarus, Georgia, Kazakhstan, Kyrgizstan, Moldova, Russia, Turkmenistan, Ukraine, and Uzbekistan. One other member of the CIS—Tajikistan—has no independent air force. In terms of airpower, strength, manpower, training, and experience of air personnel, as well as the aviation industry potential, there is no air force within the former Soviet Union (with the possible exception of Ukraine) that can match Russian airpower.

Some fundamental factors are also influencing the shape and development of non-Russian CIS air forces. These are: the multifaceted heritage of the Soviet air force, endemic strategic instability, deep and long-term economic disarray in Eurasia, as well as the airpower limitations envisioned by the Treaty on Conventional Forces in Europe (for the European members of the CIS).

The CIS air forces have predominately Soviet inventories of combat aircraft and other planes. This includes MiG-23, -25, -27, -29, -31 and Su-17, -24, -25 fighters, interceptors. and ground attack planes; Il-76, An-12, -24, -26 and Tu-134 transports; and Mi-2, -6, -8, -24, -26 helicopters. There are also a number of Czech-designed L-29 and -39 trainers.

Only the Ukrainian and Georgian air forces acquired some aircraft of Western design. By 1991, the remnants of Soviet airpower were deployed unevenly among the non-Russian republics, with 69 percent of the force stationed in Belarus, Ukraine, and Kazakhstan.

The CIS air forces are almost totally dependent on Russia for design, production, and maintenance of aircraft and personnel training. Only Ukraine is self-sufficient in training and maintenance, and it has some aircraft production capacity (the Antonov transport series is mainly of Ukrainian design). Thus, airpower remains a valuable tool for prolonging Russia's influence within the former Soviet empire.

Following the Soviet breakup, former commanders of the Red Air Force tried to preserve the centralized command and control network within the common military-strategic space of the CIS. This was to serve Russian attempts to develop the Commonwealth into an institutionalized military and political entity. As the projected CIS military functions did not materialize, the post-Soviet republics established some multilateral frameworks for airpower cooperation.

At the same time, the air forces of Moldova, Turkmenistan, Ukraine, and Uzbekistan emphasize bilateral technical cooperation. The air and air defense forces of Armenia, Belarus, Kazakhstan, and Russia conducted several exercises for the combined CIS air defense system. Ukraine and Russia are developing a collaborative project on a heavy transport plane of the next generation due to the production interdependence and growing cost of domestic aircraft design and development even for the largest CIS countries.

Since 1992, CIS air forces experienced organizational diversity: whereas Belarus, Georgia, Kazakhstan, and Turkmenistan choose to retain the Soviet-style separation of air forces and air defense, Armenia, Azerbaijan, Moldova, Ukraine, and Uzbekistan joined the services. Yet fundamental problems, aggravated by deep economic crisis, remain: widespread shortage of fuel, lack of spare parts, inadequate training of flying personnel, and inoperable aircraft.

Additionally, the bulk of the close-support aircraft (Su-24, -25) has limited tactical capacity due to obsolete navigational and combat control systems. To overcome the widespread shortcoming of tactical strike aircraft, there are attempts to use jet trainers as light close-support planes.

Peter Rainow

See also

Antonov Aircraft; Mikoyan-Guryevich MiG-29; Russian Air Force (Post-Soviet); Soviet Air Force; Sukhoi Su-24; Sukhoi Su-27

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Coningham, Arthur "Mary" (1895–1948)

RAF Air Marshal. Sir Arthur "Mary" Coningham was the architect of modern tactical airpower, creating a doctrine based upon his World War II achievements in North Africa and Europe. Born in Australia in 1895 and raised in New Zealand, Coningham endured 20 months of undistinguished World War I service in the infantry and mounted cavalry before joining the Royal Flying Corps in April 1916. He flew DH-2 and SE-5 fighter aircraft, earning distinction as commander of No. 92 squadron and his unusual nickname, "Mary," a corruption of "Maori," for his New Zealand roots.

Coningham remained in the RAF after the war and flew in England, Iraq, and Egypt, including an extraordinary round-trip flight from Cairo to Nigeria and back in 1925. From 1939 to 1941, he commanded No. 4 Group of Bomber Command in early strategic bombing efforts against Germany.

With the support of Air Chief Marshal Arthur Tedder, Coningham revamped RAF operations in the Western Desert from 1941 to 1943. He argued for prioritizing air superiority and a centralized air command coequal with ground forces, and he developed a viable air-ground support network. After the disaster at Kasserine Pass, the U.S. Army Air Forces incorporated Coningham's ideas in Field Manual 100-20, *Command and Employment of Air Power.*

Coningham's mastery of tactical air operations culminated in his command of the Second Tactical Air Force supporting the Normandy invasion and drive across France. Although Coningham was appointed head of the RAF Flying Training Command, a bitter feud with Field Marshal Bernard L. Montgomery marred his postwar service. On 30 January 1948, Coningham died in an airliner crash.

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Consolidated Aircraft Corporation (CONVAIR, Convair)

Formed by Major Reuben H. Fleet in East Greenwich, Rhode Island, on 29 May 1923 when certain aviation assets of the Dayton Wright Airplane Company and the Gallaudet Engineering Company were combined into a new company. It moved to Buffalo, New York, in 1925, then to San Diego in 1934. At the time, it had 900 employees. By 1939, the company employed 6,000 and, by the middle of 1940, had grown to more than 40,000 employees to help with the war effort. During this period, Consolidated was selected to operate a new government-built production plant in Fort Worth, Texas.

On 17 March 1943, the Consolidated Aircraft Corporation merged with Vultee Aircraft, Inc., becoming the Consolidated Vultee Aircraft Corporation. This name was often truncated to "Convair," although this did not become official until 29 April 1954, when Consolidated Vultee Aircraft Corporation became the Convair division of the General Dynamics Corporation after the two companies merged. In between, the company referred to itself alternately as CVAC or CONVAIR.

It is often reported that Consolidated was "owned" by the Atlas Corporation. As far as can be determined, Atlas was the single largest shareholder of Consolidated stock (about 430,000 of 2.4 million shares) but otherwise did not control the company. Atlas sold 400,000 of its shares to General Dynamics in April 1953, making General Dynamics the largest single shareholder. Subsequently, it purchased a majority of the stock, becoming the de facto owner of Consolidated.

The company built both civilian and military aircraft, including everything from fighters to bombers to flying boats. Among the more notable were the famed B-24 Liberator of World War II, as well as the first operational supersonic bomber—the B-58 Hustler—and the first operational swing-wing aircraft—the F-111 Aardvark. Convair was also instrumental in developing the first intercontinental ballistic missile (the Atlas), which later went on to a very successful space-launch career. In May 1994, Martin Marietta acquired the Space Systems Division (primarily Atlas and Centaur) of General Dynamics Corporation. A year later, in 1995, Lockheed and Martin Marietta merged to form Lockheed Martin Corporation. The Lockheed Martin Corporation now controls all of the defense aspects of the General Dynamics Corporation, including the San Diego and Fort Worth assembly plants that built most of the famous Convair aircraft. The last Convair aircraft—the F-16 Fighting Falcon—is still in production by Lockheed Martin in Fort Worth.

Dennis R. Jenkins

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Consolidated B-24 Liberator

U.S. heavy bomber during World War II; manufactured in greater numbers than any U.S. warplane. During late 1938, the U.S. Army Air Corps saw a need for additional heavy bombardment aircraft and approached Consolidated Aircraft to supplement B-17 Flying Fortress production by Boe-

Never given the public adulation accorded Boeing's Flying Fortress, the Consolidated B-24 Liberator was nonetheless a gallant warplane that served well in all theaters. (U.S. Air Force)

ing, Douglas, and Vega. When Consolidated president Reuben Fleet was approached, he stated that his company could build a better airplane. Consolidated began design of its Model 32 in January 1939.

By coincidence, Reuben Fleet had been approached by David R. Davis in 1937 to discuss wing-design theory. Not an aerodynamicist, Fleet insisted on having his chief engineer, Isaac Machlin "Mac" Laddon, and aerodynamicist George S. Schairer listen to the proposal. Extensive testing of the design in Cal Tech's Guggenheim wind tunnel proved Davis's concept to be far better than expected. The result was a high-aspect-ratio wing that offered excellent long-range cruise characteristics. This wing that was applied to the design of the Model 32, which became the B-24 Liberator.

The B-24 was powered by four Pratt and Whitney R-1820 engines. It had an 8,800-pound bombload, a service ceiling of 28,000 feet, a cruising speed of 215 mph, and a range of 2,100 miles. Manned by a crew of 10, the B-24H thru B-24J models mounted 10 .50-caliber machine guns for defensive armament.

The B-24 was a stablemate of the B-17 in the European theater during World War II; however, its vulnerability to battle damage and dissimilar performance compared to the B-17 led Brigadier General Curtis E. LeMay, then commander of the 3d Air Division, to remove the Liberators completely in favor of B-17s. The result was that the 1st and 3d ADs were equipped with B-17s and the 2d AD with only B-24s.

The first raid on the Ploesti oil fields was flown by 13 B-24s from the Halverson Provisional Group on the night of 11/12 June 1942, marking the first Allied heavy bombardment mission against Fortress Europe. On 1 August 1943, the famed Ploesti raid was flown under Operation TIDAL WAVE with a force of 177 B-24s from five bomb groups (three of which were loaned from the Eighth Air Force in Europe).

In the Mediterranean theater of operations, B-24s far outnumbered B-17s. Of the 21 heavy bombardment groups in the Mediterranean late in the war, 15 were equipped with B-24s. The airplanes performed well on the long-range missions deep into Germany and Austria. B-24s did far better in the Pacific theater. The missions were long, over water, with no mountainous obstacles as were encountered in the European and Mediterranean theaters, and enemy resistance was not as intense.

B-24s were also modified for specialized roles as Ferrets, photoreconnaissance platforms, fuel tankers, clandestine operations, and radio/radar jamming.

The B-24 was built in greater numbers than any other U.S. combat aircraft. A total of 19,257 B-24s, RAF Liberators, C-87 transports, and Navy PB4Y-2 Privateers were built at two Consolidated plants as well as Douglas (Tulsa), North

American (Fort Worth), and Ford (Detroit). Ford produced 6,792 complete aircraft and another 1,893 knockdown kits that were shipped by road to other plants for assembly and completion.

Alwyn T. Lloyd

See also

Ferrets

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Consolidated B-36 Peacemaker

Begun in 1941 when it appeared that the United States would have to conduct bombing missions against Europe from bases in the United States, the prototype Consolidated-Vultee XB-36 did not make its first flight until 8 August 1946. The aircraft was the ultimate expression of a piston-engine bomber, using six Pratt and Whitney R4360 Wasp radial engines, each developing 3,500 hp. Beginning with the B-36D, a pair of General Electric J47 jet engines were added under each outer wing panel to provide additional speed over the target.

The B-36 was probably the most controversial weapon developed in the immediate postwar period, with the U.S. Navy and many members of Congress arguing that the aircraft was too slow to be an effective deterrent. The Air Force countered that no current fighter aircraft could reach the bomber's 45,000-foot altitudes, and in any case it was the only aircraft available that could carry the early thermonuclear weapons (hydrogen bombs). Eventual production totaled 386 aircraft in 13 distinct versions; almost half of them were configured to conduct long-range reconnaissance and signals intelligence, in addition to retaining a nuclear delivery capability.

The B-36 never dropped a bomb in anger, but the reconnaissance versions flew numerous overflight and peripheral missions around China and the Soviet Union. The last B-36 was retired on 12 February 1959, replaced by the Boeing B-52 Stratofortress.

Dennis R. Jenkins

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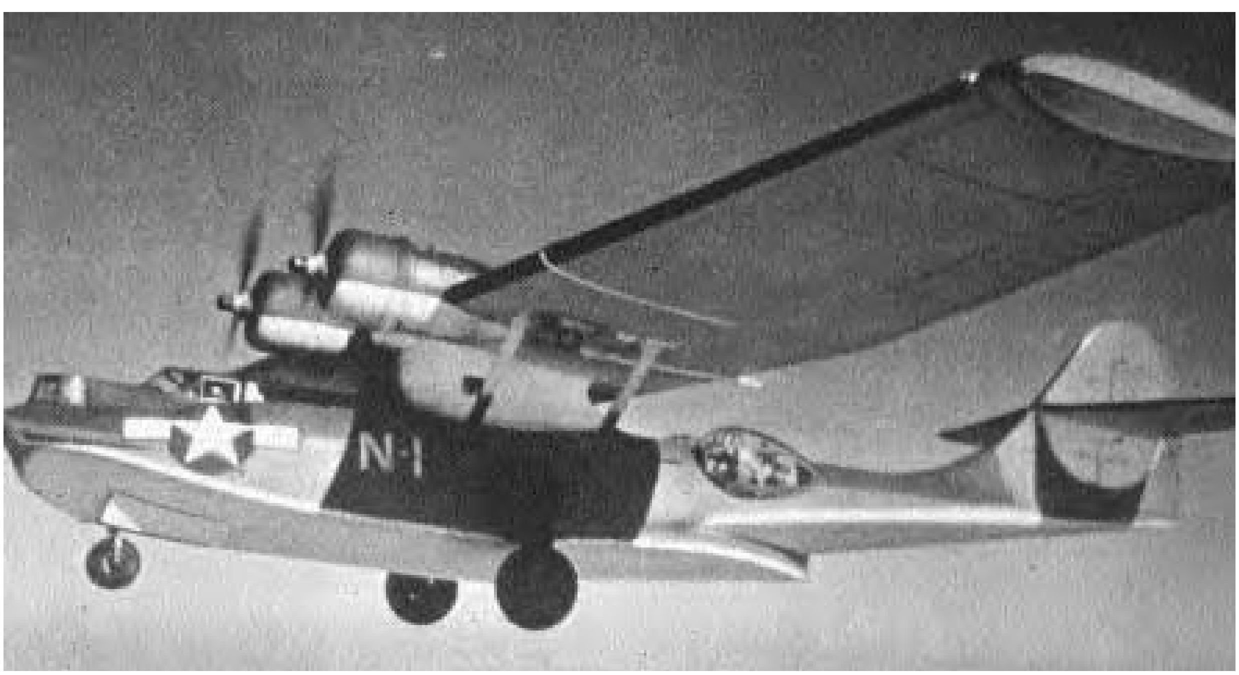
Consolidated PBY Catalina

An American amphibious aircraft noted for its distinctive shape and great versatility. The Catalina, probably the most famous flying boat in history, first flew in 1935. Early models had low production runs, but with the outbreak of war de-



Noted for its role in reconnaissance missions, the Catalina was probably the most famous flying boat in history. (Walter J. Boyne) mand rose dramatically. Australia, Canada, the Netherlands East Indies, the United Kingdom, and the United States operated Catalinas, and the Soviet Union produced a license-built version. The PBY-1 through PBY-5 were flying boats. In 1941, an amphibious version, the PBY-5A, was introduced and became the standard. Armament and speed varied between the versions, but generally Catalinas did far better to hide in a cloud rather than try to outrun or outfight an enemy. Range was generally over 2,000 miles.

Catalinas were used in an antisubmarine role and became a welcome sight to downed aviators as air-sea rescue planes. The Catalina had its greatest impact in its reconnaissance role, however. A British Catalina found the German battleship *Bismarck* after surface vessels lost contact, resulting in that ship's destruction. A U.S. Catalina located the Japanese aircraft carriers off Midway, allowing the nearby U.S. carriers to launch a crippling first strike.

Grant Weller

See also

Air Rescue; Antisubmarine Warfare; Bismarck, Air Operations Against; Consolidated Aircraft Corporation; Flying Boats; Midway, Battle of

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Continental Air Command (CONAC)

Major USAF continental command from 1948 to 1968. (CONAC is not to be confused with the Continental Air Defense Command, a joint headquarters that coordinated the air defense operations of each of the services from 1954 to 1975.) In the atmosphere of severe budgetary restraint prevalent in the late 1940s, the Air Force decided that Strategic Air Command should continue for the time being to receive first priority for resources. CONAC was therefore created in November 1948 to combine the limited resources of both Tactical Air Command (TAC) and Air (later Aerospace) Defense Command (ADC), along with related elements of the Air Force Reserve. By pooling the limited tactical assets the Air Force possessed, all under one headquarters, units could be more easily shifted to whichever mission was deemed most urgent at any given time. It soon became clear that in practice CONAC's first priority would be the air defense mission, a shift reinforced by the first test of a Soviet atomic device in August 1949.

By late 1950, following the massive expansion in defense spending associated with the Korean War and National Security Council Resolution 68, the rationale for the consolidation of TAC and ADC had disappeared. Accordingly, in November 1950 TAC was reconstituted as a major command, followed shortly in January 1951 by ADC. The remaining mission for CONAC was now to administer the Air Force Reserve and the Air National Guard and to otherwise fulfill any other miscellaneous Air Force responsibilities within the continental United States. In 1968, CONAC was inactivated, and the Air Force Reserve became a separate operating agency.

David Rezelman

See also

Air Defense Command; Air National Guard; Strategic Air Command; Tactical Air Command

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CONVAIR (Convair)

See Consolidated Aircraft Corporation

Convair B-58 Hustler

The world's first supersonic bomber. Convair's beautiful B-58 Hustler made its maiden flight on 11 November 1956. Powered by four General Electric J79 turbojet engines, the B-58 was capable of extended Mach 2 flight and set no fewer than 19 world records during its service career. The B-58 and its crews would also win the Thomson Trophy, Blériot Trophy, Mackay Trophy, Bendix Trophy, and Harmon Trophy. The B-58 was a tremendously advanced aircraft for its time but proved to be a maintenance nightmare in operational service. Nevertheless, it provided the United States with an extraordinary capability to deliver nuclear weapons during the height of the Cold War.

The B-58 was never used in combat, although some planning was accomplished toward using it in Southeast Asia. Only 116 of the bombers were produced, and they would serve operationally until they were retired in 1970.

Dennis R. Jenkins

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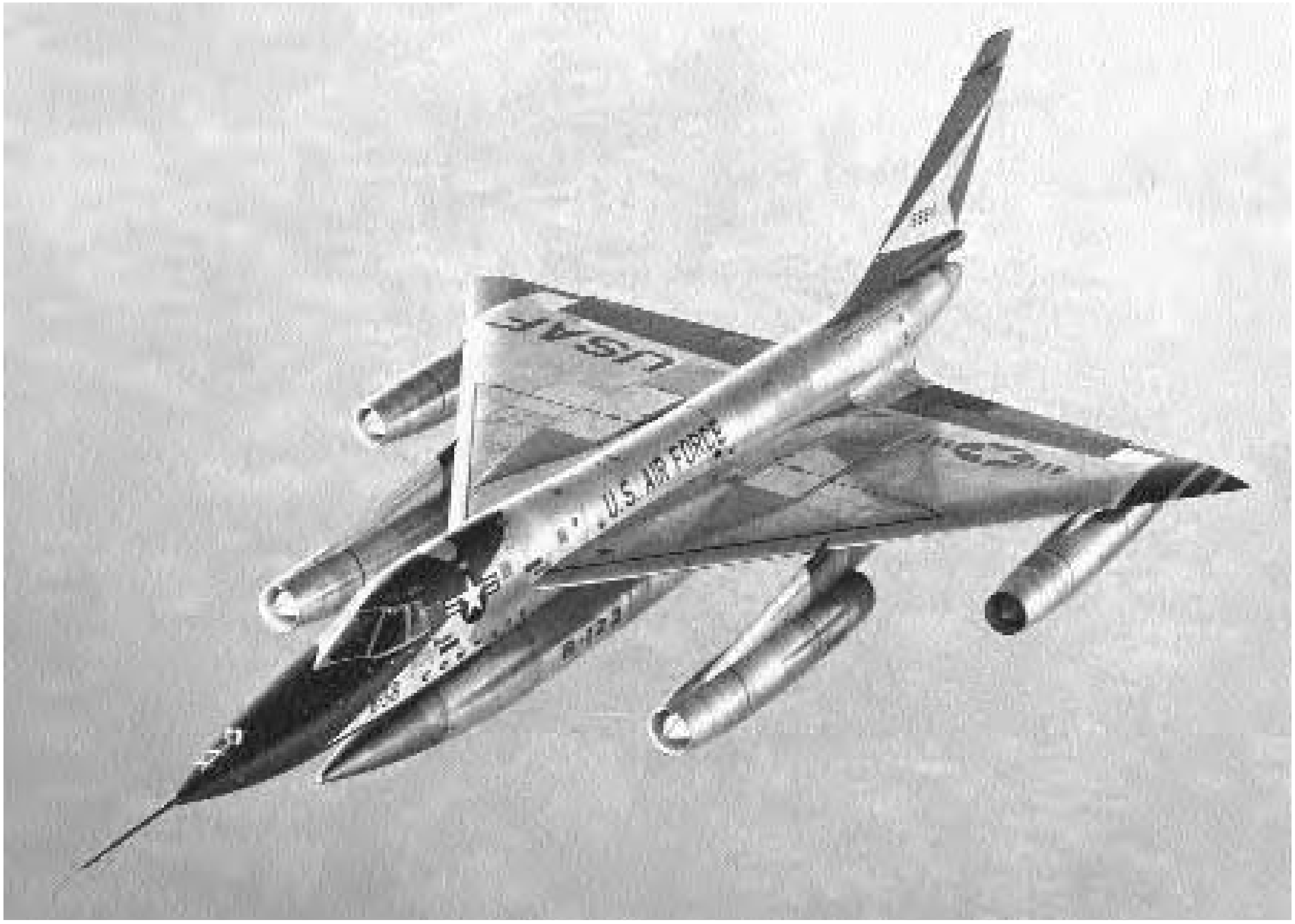

The Convair B-58 Hustler was the world's first supersonic bomber, but it proved to be expensive to operate, and many were lost in crashes. (Walter J. Boyne)

Convair F-102 Delta Dagger and F-106 Delta Dart

U.S. fighters that used the delta-wing planform that Dr. Alexander Lippisch began promoting in Germany during World War II. The concept promised high airspeeds and decent stability from a relatively lightweight airframe. When Lippisch came to the United States after the war, Convair began building an experimental fighter—the XP-92—around his delta-wing principles. The XP-92 made the first flight of an American delta-wing aircraft on 18 September 1948 and eventually conducted 118 research flights that largely validated the design.

Convair was subsequently selected to build a larger and much more sophisticated delta-wing interceptor as part of Weapons System 201A, the key defensive system designed to protect the continental United States from Soviet bomber attack. The YF-102 made its first flight on 24 October 1953, but by this time analysis had shown that the design would not attain anywhere near its proposed maximum speed because of excessive transonic drag. What saved the F-102 (and several other contemporary aircraft) was the application of National Advisory Committee for Aeronautics scientist Richard Whitcomb's so-called area-rule principle. This resulted in a characteristic fuselage, with a shape similar to a Coca-Cola bottle, and allowed the F-102A to easily achieve its design speeds.

The F-102A was not totally successful, mostly because the advanced fire-control system never lived up to expectations. This had become evident fairly early, and plans were made to proceed to an even more advanced F-102B version as soon as possible. The first operational F-102A was finally delivered on 1 May 1956, almost three years behind schedule. Convair built 875 F-102As and 63 two-seat TF-102A trainers. In 1960, the aircraft were being transferred to Air National Guard squadrons, and a few even rotated to Vietnam during 1964. By 1969, the aircraft was largely withdraw from U.S. service, and 40 were transferred to Turkey and 20 to Greece. Others were converted into PQM-102 drones.

In the meantime, Convair was developing the ultimate interceptor—the F-102B, subsequently redesignated F-106A. The airframe was unmistakably related to the F-102 but had been optimized for greater performance and to accommo-

The Convair F-106 took a long time to mature, primarily because of the sophistication of its fire control system, but it was an effective interceptor for many years. (U.S. Air Force)

date a much more powerful engine. Perhaps most important, the fire-control system was significantly improved and was well integrated into the Semiautomatic Ground Environment (SAGE, a defense network meant to provide all-weather control for the interceptor force). The first F-106A made its maiden flight on 26 December 1956, and the type began joining operational units in May 1959. Convair built 277 F-106As and 63 two-seat F-106B trainers, with the last being delivered on 20 July 1960.

The F-106 became the first front-line fighter to serve with the U.S. Air Force for more than 20 years. Interestingly, a world speed record of 1,525 mph set by an F-106A on 15 December 1959 remained unbroken during the period. From 1972 onward, the McDonnell Douglas F-15 Eagle gradually began to replace the F-106A as the continental defense interceptor. As they were removed from Air Force service, they were passed along to the Air National Guard, which flew the type until August 1988.

Dennis R. Jenkins

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Coppens, Baron Willy (1892–1986)

Belgium's "Ace of Aces." Willy Coppens transferred from the grenadiers to aviation in 1915. Delayed in training, it was not until 1917 that he made it to the front, flying the BE.2c. Finally getting a chance to fly fighters later that year, Coppens managed two unconfirmed victories plus one forced landing by the end of the year.

On 8 May 1918, he brought down the first of 35 balloons for which he would receive credit, a total that would make him the most successful balloon-buster of all time. His ultimate score of 37 put him at the head of the short list of Belgian aces. During his last mission, on 14 October 1918, he was shot down and wounded, losing a leg. His nation rewarded him with a barony, his title being Baron de Houthulst, after the forest over which many of his victories had occurred.

James Streckfuss

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Coral Sea, Battle of the (1942)

The first setback for Japan in World War II and the first naval battle where opposing surface ships did not sight each other. In April 1942, the Japanese decided to capture Port Moresby on the southern coast of New Guinea. Taking Port Moresby would drive Allied forces out of New Guinea and isolate Australia. The invasion fleet included the light carrier *Shoho* and the fleet carriers *Shokaku* and *Zuikaku.*

Warned by intelligence of Japanese intentions, Admiral Chester Nimitz ordered all available forces, including the fleet carriers *Lexington* and *Yorktown,* to concentrate and repel the attack. Between 3 and 8 May 1942, the two forces jockeyed for position, launching a series of air searches and air attacks. The Americans sank *Shoho* but lost the larger *Lexington,* plus an oiler and a destroyer, giving the Japanese a tactical victory.

However, the Americans achieved their strategic goal of defending Port Moresby when the Japanese withdrew after *Shokaku* was damaged and *Zuikaku* suffered heavy aircraft losses. The long-term importance of the Battle of the Coral Sea was its impact on the Battle of Midway in June 1942. The U.S. repaired *Yorktown* in time to take part, but the Japanese could not prepare *Shokaku* and *Zuikaku* for the battle, significantly reducing Japan's potential strength at that decisive battle.

Grant Weller

See also
Aircraft Carriers, Development of; Douglas SBD Dauntless; Grumman F4F Wildcat; Hara, Chuichi; Inouye, Shigeyoshi; Japanese Naval Air Force, Imperial; Midway, Battle of; Mitsubishi A6M Reisen; Nimitz, Chester William; Pearl Harbor; United States Navy, and Aviation; Yamamoto, Isoroku

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CORONA Spy Satellites (Discoverer)

The world's first successful spy satellites, launched initially under the public cover name DISCOVERER. In the early years of the Cold War, the United States, spurred by fears of a thermonuclear Pearl Harbor, was desperate for information on Soviet strategic nuclear weapons programs. Beginning in the summer of 1956, the high-flying U-2 spy plane began to produce some overhead imagery of the Soviet Union, but the loss of Francis Gary Powers's aircraft on 1 May 1960 led to cancellation of direct overflights of the Soviet Union. Fortunately, an alternative—and more effective—means of collecting overhead imagery was in work.

The RAND Corporation had been studying the intelligence potential of earth-orbiting satellites since 1946, but these reports were greeted with skepticism by the U.S. Air Force. Following advances associated with early intercontinental ballistic missile (ICBM) programs, however, the Air Force in October 1956 awarded the Lockheed Corporation a contract to develop the Advanced (satellite) Reconnaissance System, dubbed WS-117L. At the heart of this program was the SENTRY (later SAMOS) satellite, which would transmit digitized images directly to ground stations. Concerns over its slow progress, however, led President Dwight D. Eisenhower in February 1958 to approve an interim spinoff system that would physically return its images on film via a recoverable capsule. This program, to be run jointly by the Air Force and the Central Intelligence Agency, was given the code name CORONA.

Though the first test of the new system was ready to go in less than a year, the project was plagued with problems from the start. The first launch attempt to get off the ground, known to the public under the cover name DISCOVERER I, did place a test vehicle into orbit, but once there it was never heard from again. The 11 tests that followed, from April 1959 through June 1960, resulted only in an embarrassing series of often public failures that even included the deaths of two "crews" of four mice each, included in the flights in support of the DISCOVERER cover story.

Though it contained test instruments instead of film, the capsule from DISCOVERER XIII was successfully recovered on 11 August 1960. Finally, exactly one week later, CORONA Mission 9009 (DISCOVERER XIV) succeeded in exposing 20 pounds of film over the Soviet Union and returning it to earth, the recovery capsule being snatched literally in midair by an Air Force C-119 flying 8,500 feet over the Pacific Ocean.

Though the first CORONA satellite (later designated KH-1) took lower resolution images than did a U-2, this very first mission by itself photographed more of the Soviet Union than had all of the previous 24 U-2 overflights combined, revealing in the process 64 new airfields and 26 new surface-to-air missile sites.

Although four of the next five CORONA launches did fail, by the latter half of 1961 the system had become fairly reliable, with seven of the 11 missions from June through the end of 1961 succeeding. During this period the CORONA satellites incorporated a succession of camera upgrades, improving the ground resolution of their images from 40 feet for the KH-1, to 25 feet for the KH-2, to 10 feet for the KH-3. To manage the new influx of imagery, Director of Central Intelligence Allen Dulles on 9 August 1960 established the Committee on Overhead Reconnaissance to set CORONA target priorities, and the following year the National Reconnaissance Office was established to centralize management of all U.S. reconnaissance satellites.

In early 1962, the DISCOVERER cover story was dropped, and the workhorse of the CORONA program emerged—the KH-4. Over the next decade, 95 KH-4s (including the variants KH-4A and KH-4B) would be launched, with a success rate above 90 percent. As their service life expanded, from several days in 1960–1961 to 18 days, the quality of their now stereoscopic cameras also improved, culminating in 1967 with the J-3 camera of the KH-4B, with ground resolution of about 5 feet. (The wide-area coverage provided by KH-4s was supplemented beginning in 1964 by the first of the "close-look" GAMBIT satellites, the KH-7, with ground resolution of approximately 18 inches.) Though the KH-5 ARGON (an Army-sponsored mapping satellite) and the KH-6 LANYARD (what was left of the failed SAMOS project) did make brief appearances in 1961 and 1963, respectively, neither produced much usable imagery, and both were retired by 1964. Thus, against the initial expectations of many, it was the "interim" CORONA satellites, and especially the KH-4s, that ultimately dominated early U.S. satellite reconnaissance (along with their close-look partners, the KH-7s and KH-8s of the GAMBIT series).

The importance of these early "keyhole" satellites is difficult to overstate. In the absence of hard intelligence that prevailed in the late 1940s and well into the 1950s, the United States had been surprised several times by unexpected Soviet technological advances, such as the 1949 atomic test and the 1957 ICBM test, each occurring years earlier than had been predicted. This ambiguity regarding Soviet capabilities allowed the military services, and especially the U.S. Air Force, to indulge fears that the Soviet Union might be progressing ahead of the United States in bomber and then missile production—the so-called bomber and missile gaps. The U-2 imagery of the late 1950s strongly suggested that both of these American weaknesses were myths, but it was the images produced by CORONA satellites that definitely proved by 1961–1962 that any missile gap favored the United States.

By continuing to monitor Soviet bomber and missile deployment throughout the 1960s, CORONA imagery provided the hard data that allowed civilian policymakers within the U.S. Department of Defense essentially to freeze the size of U.S. strategic nuclear forces at those levels already reached by the early 1960s. In short, it was largely due to the CORONA satellites, and their successors, that former Director of Central Intelligence Robert Gates could boast in November 1999 that, for the United States, "during the last two-thirds of the Cold War . . . there were no more strategic surprises."

David Rezelman

See also

Antisatellite Capability; Cold War; KOSMOS; Lockheed U-2; Mutual Assured Destruction; Powers, Francis Gary; Satellites; SENTRY (SAMOS) Reconnaissance System; Sputnik

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Counterinsurgency Operations

The use of airpower for purposes of counterinsurgency can be divided into two sometimes overlapping approaches. The first and older approach is based upon directly attacking the supply lines of insurgent forces or the forces themselves. This can be accomplished by aerial bombing for interdiction purposes and the use of rockets and machine guns in a close air support (CAS) role of ground forces. Operation ARC LIGHT in Vietnam is an unusual example because B-52 carpet-bombing raids were used for CAS purposes. The second and newer approach relies upon the transport of ground forces by helicopters, the air mobility concept (pioneered by the U.S. Army in the 1960s), and, to a declining extent, the use of airborne (parachute) forces.

Counterinsurgency operations were carried out in the Middle East by the British in the 1920s, the French in Algeria and the British in Malaya after World War II, the United States in Vietnam, and the Soviet Union in Afghanistan. Typically, airpower alone will have greater counterinsurgency value in open terrain, such as deserts and scrublands, as opposed to jungles and urban zones, where much of its value is negated. With the rise of man-portable air defense systems (i.e., shoulder-fired Stinger-type surface-to-air missiles), these operations have become increasingly difficult to carry out.

Robert J. Bunker

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Coventry Air Raids

On the night of 14 November 1940, more than 500 German bombers staged the biggest air raid up to that time. The target, Coventry, was a historic British city with factories that produced bombers and military vehicles. Coventry had been bombed earlier, first on 25 June and again on 25 August, with 16 deaths. In October, many small raids killed 176. Operation MOONLIGHT SONATA, the Luftwaffe's November raid, was different. Hitler wanted revenge for the RAF's bombing of Munich, the birthplace of the Nazi Party.

At 7:00 P.M. the attack began with parachute flares followed by phosphorus incendiaries to light the way for the bombers that came at 7:30, dropping 30,000 incendiaries and 500 tons of high explosives and landmines attached to parachutes. The attack was against both the industrial outskirts and the center of the city, where a huge fire erupted. When the all-clear sounded at 6:15 A.M., 4,330 homes were destroyed and three-fourths of the factories were damaged. The raid killed 554 men, women, and children and injured 865. The level of destruction was such as the world had never before seen, and the Germans coined the word "coventrized" to describe it.

By the time of the last raid on Coventry in August 1942, the city had been through 41 actual raids and 373 siren alerts. Death by air raid in Coventry came to 1,236 people during World War II.

John Barnhill

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Crete, Battle of (1941)

In 1941, the first seizure of a strategic target by airborne forces. The German assault of Crete on 20 May 1941 served as the culmination of a lightning campaign to drive the British from the Balkans and secure a southern flank for the German invasion of Russia. It also bolstered Italy's fortunes in the Eastern Basin of the Mediterranean Sea. Luftwaffe forces included some 650 aircraft—280 level bombers, 150 dive-bombers, 180 single- and twin-engine fighters, and 40 reconnaissance aircraft. Carrying in some 15,750 paratroops and air-landed infantry were nearly 500 transports and 100 gliders. Another 7,000 mountain troops planned to follow by sea.

Opposing them were approximately 30,000 British and Imperial troops recently driven from the mainland or dispatched from Egypt, tough fighters but lacking in artillery, tanks, and air cover.

Ferocious combat began with the first of the airborne landings. German forces were very hard pressed but enjoyed good air support. Though annihilating the Germans' attempted seaborne reinforcement, the British command began evacuation on 28 May. In the fighting on and around the island, Luftwaffe forces sank three Royal Navy cruisers and six destroyers and damaged other vessels, including an aircraft carrier.

The Germans suffered grievously. Of a total of 22,000 men involved in Operation MERCURY, some 7,000 were killed and 3,400 wounded. Fully 272 transports were destroyed or damaged beyond repair. Though the paratroops' morale remained high, the Battle of Crete marked the end of large-scale Luftwaffe airborne operations.

D. R. Dorondo

See also

German Air Force (Luftwaffe); Junkers Aircraft; Junkers Ju 52/3m, Ju 87 Stuka, and Ju 88

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CROSSROADS (1946)

Code name for a gigantic peacetime exercise following World War II. The 509th Bombardment unit had dropped the two atomic bombs that brought World War II to a rapid conclusion. After World War II, the 393d Bomb Squadron, 509th Bombardment Group, was stationed at Roswell Army Air Base, New Mexico. With the postwar demobilization, the unit could barely keep its B-29s in the air for routine pilot proficiency training. Its only redeeming asset was its knowledge of atomic weapons.

In early January 1946, U.S. President Harry Truman had approved Operation CROSSROADS. This exercise required some 42,000 people, including Army, Navy, and civilian scientists. The object was to determine the effects of an air-dropped and underwater-detonated atomic weapon on naval surface vessels anchored near Enewetak Atoll. Around 2,000 USAAF personnel participated in the test with 44 aircraft.

On 1 July 1946, *Dave's Dream* (a B-29–40-MO, serial number 44–27354) from the 393d Bomb Squadron took off from Kwajalein Island under the command of Major Woodrow P. Swaincutt. Unfortunately, the day's weather forecast did not provide accurate winds, thereby leaving the crew's new bombardier, Major Harold E. Wood, to make his own assessment.

The bomb dropped that day was an Mk.2 type (codenamed "Fat Man") with a complicated set of fins. The bomb was short of the predicted area and 2,000 feet to the left. The detonation, however, was at the prescribed altitude of 500 feet. *Dave's Dream* was flown back to Albuquerque for a checkout of the bombsight. A problem with the airplane was ruled out. An analysis of the photographs taken during the drop revealed that the bomb's trajectory was not as planned, leading to the belief that one of the bomb's fins had departed the weapon.

Although the results of the airdrop were not quite as desired, the effects were substantial. The USS *Nevada* was still afloat, but five ships were sunk and another nine were severely damage. Had the ships been manned, there would have been no survivors because of the blast wave and the thermal and radiological effects.

Alwyn T. Lloyd

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CRUSADER (1941)

British code name for support of Allied ground operations in a desert environment during World War II. German Afrika Korps commander Erwin Rommel's first offensive in Africa recaptured most of Cyrenaica in the spring of 1941, but the Allies maintained control of the coastal fortress of Tobruk, cut off by land from the main Allied army. Through the summer of 1941, the Axis and Allied armies opposed each other along a line approximating the Egypt-Libya frontier. RAF bombers repeatedly struck the Italian-held ports of Benghazi and Tripoli, and RAF aircraft on Malta struck shipping and ports on the Italian mainland. Both sides rushed to gather the necessary supplies for an offensive, a race won by the British, who launched Operation CRUSADER on 18 November 1941 with the intent of relieving the Tobruk fortress.

The RAF under Air Marshal Arthur W. Tedder fielded 700 aircraft that faced only 437 Axis aircraft at forward bases, but the proximity of Italian bases in Tripolitania, Italy, and the Balkans made Axis reinforcement easier. The RAF gained a margin of air superiority for much of the battle and successfully harassed and attacked Axis columns. The open desert terrain helped considerably in successful target acquisition, particularly in attacks against German columns during the bold move by Rommel to the Egyptian frontier (the so-called Dash to the Wire).

After hard fighting, Tobruk was successfully relieved. In mid-December, the Afrika Korps and its Italian allies retreated toward El Aghelia. CRUSADER was the first significant British ground success against German forces.

Frank E. Watson

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Cuban Missile Crisis

Perilous events surrounding the construction of Soviet missile sites in Cuba. At no time in U.S. history had the importance of aerial reconnaissance been demonstrated more dramatically than during the Cuban Missile Crisis of 1962. In September and October of that year, Soviet officials had persistently denied their intent to install offensive weapons in Cuba, only 90 miles from U.S. shores, despite intelligence reports to the contrary.

On 14 October 1962, two USAF high-flying U-2 reconnaissance aircraft photographed portions of Cuba, and analysis confirmed that bases were being constructed for intermediate-range missiles within striking distance of the United States. On 16 October 1962, President John F. Kennedy reviewed reconnaissance photos of Soviet missile installations under construction in Cuba.

President Kennedy placed the U.S. armed forces on alert for whatever action might be necessary as USAF U-2 and RF-101 flights over Cuba continued, the latter aircraft sometimes flying at treetop level. The USAF Tactical Air Command (TAC) was completely mobilized as a combat force for the first time in history. In only two days, it had more than 1,000 airplanes and 15,000 personnel in southern Florida, ready for any conflict that might have developed. While Strategic Air Command (SAC) airplanes photographed Cuba from high altitude, TAC airplanes flew a constant vigil over the island at low level, obtaining photographic evidence of the communist buildup of offensive weapons.

On 22 October, President Kennedy publicly announced details of the critical situation and declared that "a strict quarantine on all offensive military equipment under shipment to Cuba is being initiated."

Meanwhile, USAF aircraft kept the island of Cuba as well as the Caribbean and Atlantic Ocean under constant surveillance, providing the U.S. Navy with data on scores of ships at sea apparently en route to Cuba. On 28 October, Soviet Premier Nikita Khrushchev agreed to remove the offensive missiles as well as the medium-range twinjet Il-28 "Beagle" bombers being assembled in Cuba. USAF reconnaissance aircraft then monitored communist compliance with the agreement.

Henry M. Holden

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Cunningham, Randall "Duke" (1941–)

U.S. Navy lieutenant, F-4 pilot, and first ace in Vietnam War (five MiG kills). Born in Los Angeles on 8 December 1941, Randall Cunningham graduated from the University of Missouri in 1964 and the following year earned a master's degree in education.

Cunningham joined the U.S. Navy in 1967 and received his wings the next year. He took his operational training at the Naval Air Station at Miramar, California, then joined Fighter Squadron 96. His first combat deployment was aboard the carrier *America* (1969–1970).

On 19 January 1972, during his second Vietnam deployment with the *Constellation,* Lieutenant Cunningham shot down a MiG-21 and, on 8 May 1972 a MiG-19. On 10 May 1972, he downed three MiG-17s. On the way back to the carrier, his plane was hit by a surface-to-air missile and downed. Cunningham and his radar intercept officer, Lieutenant (junior grade) Bill Driscoll, were picked up at the mouth of the Red River by a search-and-rescue helicopter. In all, Cunningham flew 300 Vietnam combat missions. His decorations include the Navy Cross, two Silver Stars, and the Purple Heart. Cunningham retired from the Navy in 1988, and in 1990 he was elected on the Republican ticket to the U.S. House of Representatives from California.

James H. Willbanks

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Curtiss Aircraft

U.S. manufacturer of aircraft and aircraft engines. Glenn Curtiss's lightweight, high-powered, air-cooled engines found favor among aeronautical pioneers, leading to his involvement in aviation and, in 1910, his establishment of the Curtiss Aeroplane Company.

Curtiss initially produced pusher biplanes. By 1914 that design was obsolete and tractor biplanes, designed by B. Douglas Thomas, replaced them. Curtiss also developed successful pusher flying boats and, with John C. Porte, a large multiengine example for a proposed transatlantic crossing.

War in Europe brought Curtiss substantial orders for JN trainers, large and small flying boats, and engines. America's entry into the war added still more orders. By 1918, Curtiss operated seven plants (plus a Canadian subsidiary) manufacturing aircraft and engines and accounted for more than one-third of America's wartime production.

The Curtiss firm survived postwar industry contraction because of its financial resources and management, design, and engineering talent. The superb D-12 engine, a series of racers, and the Hawk and Falcon lines of military single- and two-seaters brought the company substantial orders from 1923 onward. By 1929, the company had more than 3,000 employees.

On 26 June 1929, Curtiss merged with the Wright Aeronautical Corporation to form the Curtiss-Wright Corporation, adding an important range of air-cooled radial engines to the firm's products. The company survived the Depression, largely thanks to export orders, and transitioned to all-metal monoplane construction with its Shrike and Hawk 75 military models, ordered by both the USAAC and foreign air forces. All-metal biplane Seagulls and Helldivers for the U.S. Navy, and a successful range of small single- and twin-engine commercial aircraft produced in St. Louis, rounded out its 1930s product line.

Conflicts in China and Europe, as well as U.S. military expansion in response to the threat of international disorder, renewed demand for Curtiss products. Contracts for almost 14,000 P-40 fighters and well over 5,000 SB2C/A-25 dive-bombers formed the majority of some 28,000 Curtiss aircraft produced for U.S. and Allied forces between 1935 and 1945.

At the end of World War II, Curtiss-Wright, like all U.S. aircraft manufacturers, was hit by massive contract cancellations. Unlike some other firms, however, the only Curtiss design suitable for the postwar civil market was its twin-engine Commando, readily available in the war-surplus market. The firm's two new military prototypes, the XF15C-1 for the Navy and the four-jet XP-87, failed to attract production orders. In 1949, Curtiss-Wright closed its Aeroplane Division and sold the assets to North American Aviation.

Paul E. Fontenoy

See also
Curtiss JN-4 "Jenny"; Curtiss P-40 Warhawk; Curtiss, Glenn Hammond; Porte, John C.

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Curtiss Biplane Fighters

Although Curtiss was the largest manufacturer of aircraft during World War I, it did not produce a fighter until the end of that period (the 18-T "Wasp" triplane, of which only two were built). Curtiss built 50 Orenco D fighters in 1920, one U.S. Army Engineering Service PN-1 biplane fighter in 1920, and 34 U.S. Navy Bureau of Aeronautics TS-1 biplane fighters in 1921 under the competitive procurement program, but none was a Curtiss design or added to Curtiss's technology. In 1924 Curtiss built two TS-1s as all-metal aircraft (the original used much wood); these were designated F4C-1s.

Curtiss fighter technology got a boost from the design of racers for the Army and Navy, starting in 1921. These aircraft, the CR-1 and -2, the R-6, and the R2C/R3C, dominated Pulitzer Trophy racing, greatly influenced fighter aircraft design, and caused the diversion of the Schneider Trophy races from a sportsman's game to serious international rivalry between governments.

The PW-8 was Curtiss's first production fighter design, being rolled out January 1923, and used much of the race plane technology, including the D-12 engine, flush wing-mounted radiators, and the parallel leading and trailing edges on single-bay wings. A few months later, Boeing rolled out a similar design, the PW-9, having tapered wings that Curtiss quickly adopted for the P-1; this began a 10-year era of Army and Navy use of both companies to supply their fighters. It was not a competition, as the services desired to have two manufacturers for fighter aircraft.

The airframe was enlarged slightly to accept the larger Curtiss V-1400 and V-1570 Conqueror engines as they became available. The Army's need for trainers, which used the "AT" designation, was satisfied by fitting Hawk airframes with lower-powered Wright Hisso 200-shp engines. Most of these were later refitted with D-12s and again designated fighters.

When the Navy decided to stop using liquid-cooled en-

The Curtiss P-6 was modified over the years but retained the same basic formula of World War I fighters as an open cockpit biplane with fixed landing gear and fixed propeller. (U.S. Air Force) gines it ordered Hawks with Pratt and Whitney R1340 Wasp radial engines. The Army briefly tried the Wasp in the P-3 series but found it unsatisfactory. Early in Navy Hawk production, the F6Cs had stiffened landing gear and arresting gear. The F7C was the first Curtiss airplane designed specifically for carrier operation.

From the beginning, the Hawks had welded-steel-tube, fabric-covered fuselages and used wooden wings. The later series of biplane Hawks was built with steel wings that suffered from sympathetic vibration; these were exchanged for wooden wings. Curtiss also exploited the design in the Falcon and Helldiver lines of attack and fighter-bomber aircraft that were basically stretched and rewinged Hawks.

Douglas G. Culy

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Curtiss, Glenn Hammond (1878–1930)

One of America's pioneer aviators. Glenn Curtiss was born in 1878 in Hammondsport, New York. Like the Wright brothers, Curtiss started a bicycle shop but quickly moved into the arena of motorcycles and mechanical engines. His talent with gasoline engines brought him to the attention of Alexander Graham Bell, who asked Curtiss to join his Aeronautical Experiment Association (AEA) in Canada. Joining Bell and Curtiss in the AEA were Frederick Casey Baldwin, soon to be Canada's first aviator, J.A.D. McCurdy, and Lieutenant Thomas Selfridge, who became the airplane's first casualty. (On 17 September 1908, Selfridge died from his injuries after a crash as a passenger in Orville Wright's plane; his was the first death to occur from a heavier-than-air aircraft accident.) Bell required each of the members to build a successful heavier-than-air craft of his own design. Every aircraft built by the AEA was powered by an engine designed by Curtiss.

His flair for design and talent with engineering soon propelled Curtiss into leadership in the burgeoning field of aviation. In 1908, Curtiss introduced the AEA's third aircraft, the June Bug. He later toured with the June Bug and won the Scientific American Trophy. Curtiss often toured and competed in aviation meets worldwide. In 1909, with the help of Baldwin and McCurdy, Curtiss opened the first aircraft manufacturing company. His business partner was A. Herring, a former employee of Octave Chanute. In 1910, Curtiss opened a flying school in Hammondsport, and America's first female aviator, Blanche Stuart Scott, learned to fly there in the fall of that year.

Curtiss's career was marred by his court battles with the Wright brothers over patent infringement. The Wright brothers claimed Curtiss had stolen their ideas while visiting them in 1906 with Baldwin. In 1906, the Wrights believed Curtiss's interest in aviation was a passing interest, and they were not threatened by his interest and questions. The Wrights gave the AEA advice and offered sources where their work had been published. Apparently many of the Wrights' published suggestions were found on "June Bug," but the Wrights were not given credit. The battle was drawn out and hostile, but with the threat of World War and the need to increase production of warplanes, the case was finally settled in 1917.

Curtiss continued advancing his work by employing skilled designers, some from Great Britain, and creating one of the most popular American aircraft of World War I—the JN-4 "Jenny." Due to postwar surplus, many aviators were able to purchase the Jenny, becoming barnstormers. This aircraft was responsible for training a majority of America's war-time pilots and was equally important in the postwar years.

Court battles so sapped Curtiss's creative energy that he moved to Florida and became a real estate developer. He died in Florida at the age of 52.

Wendy Coble

See also

Curtiss JN-4 "Jenny"

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Curtiss JN-4 "Jenny"

World War I U.S. training aircraft. The Curtiss JN-4, affectionately referred to as the "Jenny," was the first mass-produced aircraft in America. The Jenny was without a doubt this country's most famous aircraft during World War I and remained so for several years afterward.

The idea behind the birth of the Jenny arose from concerns by U.S. military aviation officials over the dismal safety record of existing pusher-type aircraft. As a consequence, the Curtiss Aeroplane and Motor Company hired British aircraft designer B. Douglas Thomas to develop a tractor-type aircraft to replace the deadly pushers. Thomas, who had experience with both the Avro and Sopwith aircraft companies in England, soon came up with the Model J. The best characteristics of this aircraft were combined with those of the Curtiss Model N, culminating in a docile yet attractive two-seater aircraft designated the JN, which quickly evolved to Jenny. The JN promptly went into production at various locations throughout the United States, progressing through several designations, the most common of which was the JN-4.

The Jenny soon became the standard military trainer in the United States during World War I and for several years afterward. In addition to its use by all three major service branches of the U.S. military, Canada, England, and Spain also used various models of the Jenny as a basic trainer during 1917–1918. The most common version was powered by the 90-hp OX-5 engine.

Although most Jennies were used as basic flight trainers, some were equipped for more advanced training with machine guns, bomb racks, and the more powerful 150-hp Wright-Hispano engine. By the time production finally ended, more than 8,000 Jennies of several variants had been manufactured in the United States and Canada, and it had taught tens of thousands of aspiring aviators to fly. Indeed, 95 percent of all U.S. wartime pilots learned to fly in a Jenny. This adaptable aircraft remained in the U.S. military inventory until late 1927.

The wartime significance of the Jenny is undisputed, but it did not reach immortality status until after the war, when thousands of surplus aircraft were put on the public market. Selling well below cost—in some cases less than $100—the Jenny became America's premier barnstorming aircraft. Hundreds of former wartime pilots wandered like flying gypsies throughout America during the 1920s, stunting, giving rides, and putting on impromptu aerial demonstrations with their surplus Jennies.

Steven A. Ruffin

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Curtiss P-40 Warhawk

World War II U.S. fighter. The Curtiss P-40 Warhawk, made famous by the legendary Flying Tigers, was one of America's most important fighter aircraft of World War II. The P-40 originated in 1938 as the XP-40, a derivation of the mid-1930s Curtiss radial-engine design, the P-36 Hawk. Unlike the Hawk, however, the P-40 was equipped with a liquid-cooled Allison V-1710-33 inline engine, which greatly reduced frontal area and increased performance.

Although the P-40 was sturdy, with good diving characteristics and an attractive, sleek-looking design, it exhibited only mediocre performance compared to most other fighters of the day. By the start of the war, in fact, the P-40 was virtually obsolete. Still, it continued to be produced in great numbers, as it was one of the few fighters already in full production and readily available from war's outset.

The P-40's chief claim to fame was its use by General Claire Chennault's American Volunteer Group (AVG), immortalized as the Flying Tigers. The AVG operated in China under the control of General Chiang Kai-shek in the early months of World War II. With the colorful but intimidating shark's teeth painted on their noses, the P-40 fighter aircraft flown by the flamboyant and highly capable pilots of the AVG were extremely successful in intercepting and destroying invading Japanese aircraft. Although consistently outnumbered, pilots flying the P-40 registered a kill ratio of 25 Japanese aircraft for every P-40 destroyed in aerial combat. Because of its effectiveness, as well as the popular cause the AVG supported, the P-40 became one of the most recognized aircraft in history.

The P-40 saw extensive service throughout World War II—beginning with the actual attack on Pearl Harbor. In addition to its use by the United States, the P-40 was used by 28 Allied nations, including the British in North Africa, the Australians in the South Pacific, and the Russians on the Eastern Front. Indeed, even as late as 1943 the P-40—in combination with the Bell P-39—still represented over half of the total fighter strength in the U.S. Army Air Forces.

The P-40 underwent numerous design modifications throughout the war, but when the far superior P-38, P-47, and P-51 fighters arrived on the scene, the P-40 was quickly relegated to roles other than air-to-air combat, such as ground support. By the end of the war, only one U.S. squadron was still equipped with the P-40.

The rugged P-40 played a significant role in winning the war because it was available at a time when most other World War II fighters were still in the planning stages, and it performed dependably and effectively until more advanced fighters became available. Even though a total of 13,738 P-40s were built from May 1940 through 1944, only a handful of these classic and historic aircraft are still flying today.

Steven A. Ruffin and Daniel A. Ruffin

See also

American Volunteer Group; Bell P-39 Airacobra and P-63 Kingcobra

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The Curtiss P-40 achieved its greatest fame with the Flying Tigers, but it also proved itself in every theater of war. Rarely the fastest or most maneuverable aircraft in a combat, it was often the most rugged and served its nation well. (U.S. Air Force)

Rubenstein, Murry, and Richard M. Goldman. *To Join with the Eagles: Curtiss-Wright Aircraft, 1903–1965.* New York: Doubleday, 1974.

Curtiss-Wright Corporation

U.S. aircraft manufacturing company. The Curtiss-Wright Corporation was one of the largest aircraft manufacturing companies in the United States before and during World War II. Its contribution to the war effort was so significant that it was said to be second only to General Motors as a manufacturer of war goods.

Curtiss-Wright was founded in 1929 with the somewhat unlikely merger of two old enemies, the Curtiss Aeroplane and Motor Company and the Wright Aeronautical Corporation. Throughout the 1930s, the company flourished, producing airframes, propellers, and engines for both military and commercial aircraft in the United States, as well as for numerous foreign countries.

As the buildup for World War II began, Curtiss-Wright rapidly expanded to several locations throughout the United States, increasing plant capacity tenfold from 1939 to 1941. By the time the United States entered the war, the company operated 15 factories, occupying 11 million square feet of space and employing 50,000 workers, and it had a backlog of orders totaling $1 billion.

During its heyday, Curtiss-Wright manufactured numerous types of aircraft, many now regarded as classic, such as the Curtiss Helldiver and the Curtiss C-46 Commando transport. But without a doubt the most famous and successful Curtiss aircraft was the P-40 Warhawk, immortalized as the shark-nosed fighter flown by the famed Flying Tigers. Already in full-scale production at the start of the war, this aircraft was produced continuously until the end of 1944. By the end of the war, Curtiss-Wright had produced more than 140,000 aircraft engines and propellers and nearly 30,000 aircraft.

When the war ended, military aircraft orders came to a virtual standstill, and even though Curtiss-Wright was financially sound, the company went into a decline. Unlike other aircraft companies, which were able to transition to new technologies, a peacetime economy, and civilian aircraft production, Curtiss-Wright lagged in the development of successful postwar civilian aircraft designs. Instead, the company opted to concentrate its efforts on engine and propeller production alone. By 1950, Curtiss-Wright was in effect no longer in the aircraft manufacturing business.

The company continued to manufacture engines until 1983, when that part of its operation was discontinued as

One of the most beautiful biplane fighters ever built, the Curtiss P-6E appeared at its best in the colors of the 17th Pursuit Squadron of the 1st Pursuit Group. (U.S. Air Force)

well. Once a world giant in the field of aviation, the Curtiss-Wright Corporation has continued to survive by diversifying its efforts into a variety of ventures, not all of which are related to aviation. And even though today the company's name is the only remaining hint of its aviation heritage, the Curtiss-Wright Corporation still continues to prosper.

Steven A. Ruffin

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D

Dargue, Herbert A. (1886–1941)

Major general in the U.S. military. Herbert Arthur "Bert" Dargue was born in New Jersey on 17 November 1886. After a brief career as a schoolteacher, he entered the U.S. Military Academy in 1907, graduating in 1911 as a lieutenant of coast artillery. He was rated a military aviator in 1913 after transferring to the Signal Corps and taking flight training in the Philippine aviation school.

In December 1914, Dargue and Lieutenant J. O. Mauborgne became the first Army airmen to both transmit and receive inflight radio messages, operating a wireless unit they had designed and built. Soon afterward, Dargue was transferred to San Diego, California, as a flight instructor. Following that tour, he was assigned to the 1st Aero Squadron in San Antonio, Texas. He participated in the campaign of 1916 that pursued the rebel leader Pancho Villa deep into the interior of Mexico. Forced landings were frequent, and Dargue and his observer once hiked for three days back to friendly territory after crashing behind Villa's lines.

During World War I, Dargue first helped establish, and then commanded, the Aerial Observer School at Fort Sill, Oklahoma. He later went to France at the direction of the chief of the Signal Corps as a special observer to report on the readiness of training and combat air units.

After the war, he graduated from both the Army and Navy War Colleges. He and Hap Arnold were close friends of General Billy Mitchell, whom they counseled in vain to stay within the military chain of command in his fight for an independent air force; both were strong proponents.

In 1926, Dargue was chosen to lead the record-setting Pan-American Goodwill Flight, which circumnavigated the South American continent in Loening 0A-1A amphibians. He and his copilot parachuted to safety after a midair collision over Buenos Aires that killed the crew of the other aircraft. He led the flight back to the United States in a replacement Loening, and in 1927 he and the other surviving members of the Goodwill Flight were awarded the first Distinguished Flying Crosses by President Calvin Coolidge.

He was later assigned to Langley Field, Virginia, as commanding officer of the 2d Bombardment Group, flying Keystone B-3A aircraft. While there, he conceived and developed many of the strategic bombing plans and aircraft formations used by the U.S. Army Air Forces in World War II.

During the 1930s, he led development and testing of the Norden precision bombsight, a top-secret weapon that contributed greatly to the success of World War II USAAF bombing missions in Europe and the Pacific.

In late 1941, Major General Dargue commanded the First Air Force at Mitchell Field, New York. After the Pearl Harbor attack, he was chosen by Secretary of War Henry Stimson to take command of Army forces in Hawaii; en route, the B-18 he was piloting crashed in the Sierra Nevada Mountains of California, killing all aboard.

James Snyder

Dassault, Marcel (1892–1986)

French aircraft designer and industrialist, born Marcel Bloch in Paris on 22 January 1892. Dassault companies built the most successful military aircraft in Europe in the decades after World War II.

The son of a Jewish physician, Bloch obtained degrees in aeronautical design and electrical engineering. In addition, he worked as an aircraft designer for France during World War I. There, he engaged in real estate in the 1920s but returned to aeronautics in 1930, starting his own company

The Dassault Mirage IIIC all-weather interceptor, one of the many variants of the successful Mirage design. (Walter J. Boyne)

and building military and civilian airplanes with notable success and profitability. During World War II, he refused to work for the Germans, and as a consequence Bloch was sent to the Buchenwald concentration camp.

After the war, Bloch changed his last name to Dassault (a nom de guerre of one of his brothers in the Resistance) and converted to Roman Catholicism. His aircraft manufacturing company, Générale Aéronautique Marcel Dassault, led the postwar revival of the French aircraft industry, producing Europe's first supersonic plane, the Mystère, as well as the highly successful Mirage line of delta-winged military aircraft in 1956. The Mirage symbolized modern aerial combat and brought additional trade to France and incalculable prestige, especially in defense hardware. The various Mirage warplanes proved very popular among neutral and Third World nations and became some of the most widely used military aircraft in the world.

In 1967, Dassault's company merged with Breguet Aviation, a manufacturer of transport aircraft, to form Avions Marcel Dassault–Breguet Aviation. In addition, Dassault was a deputy in the National Assembly from 1951 to 1955 and from 1958 to 1986.

In January 1976, Marcel Dassault announced that he was launching a private venture to build the Delta Super Mirage as a long-range multirole aircraft for export, but it was canceled. As a replacement, the French government announced a decision to award a study contract with Marcel Dassault for a smaller and simpler single-engine delta fighter outwardly very much like the Mirage III of 20 years earlier. The result was the Mirage 2000, currently in service with a number of foreign countries. Marcel Dassault died in Paris on 18 April 1986. The Lycée Marcel Dassault, a famous technological and scientific institute in Rochefort, France, carries his name.

Albert Atkins

See also
Dassault Mirage III; Dassault Mystère IVA

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Dassault Mirage III

One of the most successful European military aircraft of its generation. The French Mirage has been adopted by the air arms of many overseas customers, as well as by the Armée de l'Air (the French air force). Equally adaptable for the low-level ground attack or high-altitude intercept roles, the Mirage began life as an attempt to produce the smallest practicable all-weather interceptor capable of attaining an altitude of 60,000 feet in six minutes and fulfilling an Armée de l'Air specification. The first model, the MD.550 Mirage I, which flew on 25 June 1955, was intended essentially to prove the practicability of the tailless delta configuration; it was powered by two 1,640–pound/thrust Bristol-Siddeley Viper turbojets. Weighing only 7,341 pounds empty and 11,177 pounds loaded, the Mirage I attained Mach 1.15 in a shallow dive. With additional power, Mach 1.3 was attained in level flight on 17 December 1956.

The Mirage II was also hampered by insufficient engine power and was succeeded by the Mirage III. Considerably larger than the Mirage I and some 30 percent heavier, the Mirage III retained the 5 percent thickness-to-chord ratio, with a leading edge sweep of 60 degrees, and used a single SNECMA Atar 101G.1 turbojet offering an afterburning thrust of 8,818 pounds. The Mirage III-001 flew for the first time on 17 November 1956, attaining Mach 1.6 in a dive on 30 January 1957. With afterburning, maximum level speed was raised from Mach 1.52 to Mach 1.65. A speed of Mach 1.8 (1,188 mph) was later attained with the aid of an SEPR 66 rocket.

The Mirage III was, in its initial form, intended solely for the intercept role, and a demand for a wider versatility resulted in a multipurpose Mirage IIIA, which differed from its immediate predecessor in a number of respects. Wing area was increased, and the leading edge was provided with conical camber and an axial "notch." The fuselage was lengthened to accommodate the Atar 09, a supersonic engine with additional compressor and turbine stages to those of the Atar 101G rated at 9,370 pounds/thrust and 13,230 pounds/thrust with afterburning, and provision was made for a detachable SEPR 841 rocket pack offering 1,500 pounds/thrust for 160 seconds or 3,000 pounds/thrust for 80 seconds.

The first "preseries" aircraft the Mirage IIIA-01 flew on 12 May 1958, and in six months, on 24 October, the aircraft attained Mach 2.0 in level flight without the rocket motor mounted, the SEPR 841 being first tested on the Mirage IIIA-02. The Mirage IIIA-05 was the first aircraft to be completed to full production standard, effectively being a prototype for the initial production model, the Mirage IIIC, which was visually almost indistinguishable from the preseries aircraft.

Albert Atkins

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Dassault Mystère IVA

The French Mystère series of aircraft was among the most important to appear in the West and maintained France's indigenous aircraft industry. A variety of Mystère aircraft was produced to meet many different national needs.

The Mystère IVA remained in service with the Armée de l'Air (the French air force) until 1964. Dassault built 421 examples of this interceptor before production ended in 1958. One hundred and ten were delivered to India, 60 to Israel, and the remainder to the Armée de l'Air.

Bearing more than a general aerodynamic resemblance to its immediate predecessor, only 150 production examples of the Mystère IIC saw limited service with the Armée de l'Air. The Mystère IVA featured a more robust, oval-section fuselage, a wing of increased sweepback and reduced thickness-to-chord ratio, and a more powerful turbojet. The Mystère IVA-01 flew for the first time on 28 September 1952. The first 50 Mystère IVA fighters manufactured for the Armée de l'Air were powered by the 6,280-pounds/thrust Hispano Suiza Tay 250A turbojet, and the type entered service in 1955. All subsequent Mystère IVAs received the more powerful Verdon 350.

The first prototype of the Super Mystère B.1 flew on 2 March 1955, powered by a Rolls-Royce Avon R.A. 7R turbojet. The first of five Atar-powered preproduction Super Mystère B.2s followed on 15 May 1956. The primary role of the Super Mystère B.2 was that of day interceptor, but a variety of underwing stores made it suitable for the fighter-bomber role. The Super Mystère B.2 equipped two squadrons of the 5th Armée de l'Air and one squadron of the Israeli Air Force. One hundred and eighty Super Mystère B.2s were completed when production terminated in 1959.

Albert Atkins

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Davis, Benjamin Oliver Jr. (1912–)

U.S. general. Benjamin Oliver Davis Jr. was born in Washington, D.C., on 18 December 1912 to Benjamin Oliver and Elnora Davis. His father had been the first African American to attend the United States Military Academy (USMA) and later, in 1940, the first African American to become an Army brigadier general.

Davis was only the second African American accepted at West Point, his father being the first. Once at the USMA, Davis had to endure four long years of what cadets called "the silent treatment." His classmates and instructors never spoke to him except to give him orders or instructions. Davis persevered and graduated in June 1936, thirty-fifth out of a class of 276.

Soon after graduation, he married Agatha Scott, who became his life partner and strongest supporter. Upon graduation, Davis applied for pilot training but was instead assigned to the infantry. Captain Davis was sent to the Tuskegee Institute in Alabama to teach military science. Soon, the need for personnel brought on by the war in Europe led to Davis and 12 other black cadets receiving flight training at Tuskegee. Davis and three others received their wings in March 1942. This group formed the cadre of the all-black 99th Pursuit Squadron formed later that year.

The 99th was deployed to North Africa in June 1943, flying older Curtiss P-40 Warhawks, and was not allowed to fly combat missions. After four months, Davis rotated home. White officers argued that the black pilots were too cowardly to fly combat. Davis countered that they had not been given a fair chance. After a tense several weeks, U.S. Army Air Forces leaders, no doubt pressured by the White House, directed that select black pilots be allowed to fly combat missions.

In late 1943, Davis took command of the 332d Fighter Group and was promoted to lieutenant colonel. In January 1944, the 332d deployed to Italy and by May had transitioned to Republic P-47 Thunderbolts.

On 9 June, Davis led 39 P-47s escorting Consolidated B-24s on a raid on Munich. Over the target they engaged more than 100 Messerschmitt Bf 109 fighters, downing five and damaging many others. For his leadership Davis won the Distinguished Flying Cross, which was pinned on by his father. During the raid the 332d continued a tradition it maintained throughout the war. During 200 escort missions it never lost a bomber under its protection.

By 1945, the 332d had transitioned to North American P-51 Mustangs, which were painted with a distinctive red tail and nose. As such, the unit became known as the "Red Tails." By the end of the war in Europe, the unit had flown 15,000 sorties, downed 111 enemy planes, and destroyed 150 on the ground with a loss of 66 aircraft. It received the Presidential Unit Citation.

After the war, Colonel Davis became an influential advocate for integration of the U.S. military and an example of making it happen. In 1946, he assumed a difficult assignment when he became commander of Lockbourne AFB, Ohio. While he gained the distinction of being the first African American to command an air installation, the local community in Columbus was not happy with a black unit and a black commander. It was to Davis's credit that by the time he left in 1949 local relations had dramatically improved.

In the early 1950s, Davis commanded the 477th Composite Group and 332d Fighter Wing. In 1953, he again saw combat as commander of the 51st Fighter-Interceptor Wing flying North American F-86 Sabre jets in Korea. In late 1953, following the war, Davis became the first African American to become an Air Force brigadier general.

In 1959, he became a major general and then made lieutenant general in 1965. In 1967, Davis took command of the Thirteenth Air Force stationed at Clark AFB in the Philippines, flying combat sorties during the Vietnam War. His final assignment was a concurrent position as deputy commander in chief (CINC), U.S. Strike Command, and Deputy CINC, Middle East.

General Davis retired in late 1970 after 34 years in service. President Richard M. Nixon appointed him director of civil aviation security. In June 1971, he was promoted to assistant secretary of transportation for environmental, safety, and consumer affairs.

Davis retired from the Department of Transportation in 1975 and received its National Gold Medal. Among his many awards he received the Distinguished Flying Cross, the Army and Air Force Distinguished Service Medals, Silver Star, Croix de Guerre, Air Medal with five Oak Leaf Clusters, three Legions of Merit, the UN Service Medal, Langley Medal from the Smithsonian Institution, and the Thomas D. White National Defense Award.

In 1991, Davis published his memoir (*Benjamin O. Davis, Jr., American: An Autobiography*), detailing his trials and successes. On 15 February 1997, the U.S. Post Office issued a stamp honoring Davis and all African American service personnel. On 8 December 1998, President Bill Clinton, during a ceremony at the White House, promoted Davis to the rank of four-star general. General Daniel "Chappie" James had been the first black Air Force four-star, but many believed that Davis should have been and that this was a long-overdue honor for a pioneer of airpower and equal rights.

At this writing, the Davises live in the Washington, D.C., area. He remains an active advocate for strong national defense, a strong Air Force, and equal opportunity for all Americans.

William Head and Brian Head

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The de Havilland Vampire was first flown in September 1943 and remained in use with the Swiss air force into the 1990s. Shown here is Geoffrey de Havilland, Jr., who would be killed in the 1946 crash of the de Havilland D.H. 108 Swallow. (Walter J. Boyne)

De Havilland Aircraft (Early Years and World War I)

British aircraft manufacturer. George Thomas had acquired the British rights to Farman aircraft in 1911 and used the interest to found the Aircraft Company, Ltd. (Airco). In 1914, at Geoffrey de Havilland's urging, Holt undertook the manufacture of original designs and hired de Havilland to head the design department.

Throughout the war, Airco designs were prefixed with the letters "DH," indicating their designer, Geoffrey de Havilland. By war's end, the fame of this prefix had eclipsed the name of the manufacturer, and the aircraft were known everywhere as de Havillands.

De Havilland's early designs were pushers, a layout dictated by the lack of a workable interrupter gear. His first success was the D.H. 2, the single-seat pusher that, along with the Nieuport 11, ended the reign of the Fokker Eindecker.

The D.H. 3 was intended as a heavy bomber but never made it past the prototype stage. It did, however, serve as the basis for the later D.H. 10.

His next effort, the D.H. 4, was a tractor design powered by a Rolls-Royce engine. One of the most successful types to come out of Airco, the de Havilland D.H. 4 first appeared in 1917. It was a two-seat light daytime bomber powered by a 375-hp Rolls-Royce Eagle VIII engine. Intended for use against tactical targets, it could carry four 100-pound bombs on external racks under the lower wing. Defensively, it was equipped with a synchronized Vickers .303-caliber machine gun for the pilot and one or two .303-caliber Lewis guns mounted on a rotating Scarff ring for use by the observer. Its real defense, however, lay in its great speed, which allowed it to outrun pursuing German fighters.

Replaced in due course by the D.H. 9 and D.H. 9a, the D.H. 4 got a new lease on life in 1918, when it entered service with the U.S. Air Service. Powered in that role by the new Liberty engine, the DH-4 (its American designation) became the only aircraft manufactured in the United States to see action in World War I.

The D.H. 5 was a departure for de Havilland. A single-seater, its layout employed negative stagger to maximize the pilot's view so the aircraft could be used for ground attack.

The next product, the D.H. 6, was an inexpensive trainer, its "wings built by the mile and cut off by the yard." Its angular wings and control surfaces enabled easy, inexpensive construction. As it happened, the aircraft also proved useful on coastal patrol duties.

The D.H. 9 was a revised D.H. 4, intended for the Siddeley Puma engine. When the engine did not live up to its potential, however, the design was re-engined with the Rolls-Royce Eagle VIII or the American Liberty and emerged as the D.H. 9a.

De Havilland's last wartime effort was the D.H. 10, a second attempt to produce a heavy bomber. Had the war continued, this aircraft would have competed with the Handley Page and Vickers Vimy.

James Streckfuss

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De Havilland Aircraft (Post–World War I)

Geoffrey de Havilland formed De Havilland Aircraft Company on 25 September 1920, following the closing of the wartime Airco, for which he was chief designer and where he designed the classic de Havilland D.H. 4, among others.

A whole series of aircraft flowed from the de Havilland plant, including bombers, fighters, sportplanes, racers, trainers, transports, and ultra-lightweight aircraft. The first military aircraft produced by the de Havilland plant was the D.H. 27 Derby, a large, single-engine bomber prototype that did not receive any production orders.

The most prominent design of the 1920s and 1930s was the D.H. 60 Moth series, which was sold all over the world to both civil and military customers and led directly to the classic de Havilland D.H. 82A Tiger Moth, which became the RAF's standard basic trainer for many years; more than 8,000 were built.

Other classic designs included the twin- and four-engine biplane transports, the famous Puss Moth sportplane, and the de Havilland D.H. 88 Comet that won the 1934 London-to-Australia race. The Comet featured wooden stressed-skin construction that would appear again on the elegant D.H. 91 Albatross four-engine transport and the incomparable D.H. 98 Mosquito.

De Havilland design and construction lent itself to the jet age, and there appeared a series of fighters, including the Vampire, Venom, and Sea Vixen. Commercial aircraft included the twin-engine Dove and four-engine Heron.

The most brilliant, if also the most tragic, de Havilland effort in the postwar years was undoubtedly the stunning D.H. 106 Comet, the first jet airliner to see service. Although an otherwise masterful design, it fell prey to the lack of experience in building large airliners with pressurized cabins and encountered fatigue problems that caused crashes and forced its withdrawal from service. Later-model Comets were built that had overcome the design flaw, but the design never recovered its initial momentum and was superseded by Boeing and Douglas airliners.

De Havilland built the successful Trident, which sold in small numbers but was succeeded by the highly successful Hawker-Siddeley H.S. 121 after de Havilland was absorbed by that corporation. It also built the de Havilland D.H. 125 executive jet, which was also built in greater numbers by Hawker-Siddeley.

De Havilland also built aircraft in Australia and Canada. In Canada, the company became famous for its Chipmunk trainer and the Beaver and Otter bush transports. The DHC-4 Caribou was used extensively by the United States Army (and later by the USAF) and led to a whole series of designs including the DHC-5 Buffalo, DHC-6 Twin Otter, DHC-7 Dash 7, and DHC-8 Dash 8. The company was acquired by Boeing, which in turn sold it to Bombardier Aerospace.

Walter J. Boyne

See also
de Havilland D.H. 82 Tiger Moth; de Havilland D.H. 98 Mosquito

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De Havilland D.H. 98 Mosquito

Classic British multimission aircraft from World War II. The de Havilland D.H. 98 Mosquito was a private venture of the De Havilland Aircraft Company, building on their experience in wood construction gained on the de Havilland Comet and other aircraft. It was built mainly of plywood molded to complex shapes. A pair of Merlin engines powered the Mosquito, which was fast and maneuverable.

Successive variants appeared, each with increased power, improved propellers, and a wide variety of equipment. Some aircraft were pressurized for operation at extreme altitudes.

The final two variants of the Mosquito remained in Royal Air Force operational service until replaced by the Canberra PR.3 in 1955. Some examples remained in use as target tugs until 1961.

The Mosquito bomber role first entered RAF service in November 1941. It was employed in both day and night operations and often performed diversionary raids. Further changes of operation saw the Mosquitos flying at night in the Pathfinder target-marking role where they dropped incendiaries to mark targets for the following bomber fleets. Although target-marking was the primary mission, the Pathfinders also carried high-explosive weapons to supplement the main load.

Its speed and maneuverability made the Mosquito effective as a fighter. Three distinct versions were employed—for ground attack, antishipping, and as a night-fighter.

One of the most successful aircraft of the war, the de Havilland Mosquito combined high speed, long range, and good load capability in a single aircraft. (Kev Darling)

The Mosquito was also deployed to the Far East theater of operations, where it replaced the Bristol Blenheim. During the war the USAAF flew the reconnaissance version over Italy. Surplus aircraft also entered service with the air forces of Belgium, Norway, and Sweden and others.

Kev Darling

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De Havilland Tiger Moth

British trainer during World War II. De Havilland's Tiger Moth served the Royal Air Force in a training role for more than 15 years before being replaced by the Percival Prentice and the de Havilland Canada Chipmunk.

Developed from the earlier Gypsy Moth, the Tiger Moth featured staggered and slightly swept wings, mainly to aid better egress from the front cockpit while wearing a parachute. The engine was mounted in the inverted position to improve forward vision, and other detail improvements aided stability and handling. After acceptance testing, the Tiger Moth was cleared for full blind flying and the full range of aerobatics.

A first production batch was delivered to the Central Flying School in early 1932. These were followed by Mk.II versions, which were fitted with a slightly more powerful Gypsy Major engine rated at 130 horsepower. Slightly later in their career they were fitted with antispin strakes to improve stability.

When war was declared against Germany in September 1939, more than 1,000 aircraft had been delivered to elementary and reserve training schools. Eventually, 4,200 Tiger Moths were built in Britain; large quantities were also built in Canada, Australia, and New Zealand for use in the Commonwealth Air Training plan. The Tiger Moth was eventually phased out in 1951. There was one other variant of the Tiger Moth, the Queen Bee, which was a radio-controlled pilotless target used for live firing practice. The Bee was available in both landplane and floatplane versions.

Kev Darling

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Defense Advanced Research Projects Agency (DARPA)

Manages and directs selected basic and applied research and development projects for the U.S. Department of Defense. It also pursues research and technology where risk and payoff are both very high and where success may provide dramatic advances for traditional military roles and missions.

U.S. Secretary of Defense Neil H. McElroy created the Advanced Research Projects Agency (ARPA) on 8 February 1958 as a new agency for space technology and development with complete authority for direction of the growing space program. Today ARPA is best known as the creator of the Internet. ARPA Director Roy W. Johnson intended ARPA to be a "fourth service," in effect a national space agency. In 1950, the Department of Defense had assigned military satellites to the Air Force. Now program direction came from ARPA. Another government agency had taken over the Air Force's plans for a space program. However, that proscriptive role was very short-lived.

In October 1958, the National Aeronautics and Space Administration (NASA) became a reality, inheriting existing scientific satellites and planetary missions from the National Science Foundation and ARPA. The act creating NASA divided U.S. space activities between the public NASA civilian world and the private ARPA military world. ARPA lost its dominant role in December 1959 when the Department of Defense divided the responsibility for the various military satellite missions among all three services, redesignating ARPA as a research and development agency. In 1961, the department assigned research, development, test, and engineering for all space programs back to the Air Force, except for "unusual circumstances." Any defense department agency, however, could conduct preliminary research.

In 1972, the name was changed to the Defense Advanced Research Projects Agency. In 1993, DARPA was re-redesignated ARPA. In 1996, the Defense Authorization Act directed an organizational name change to DARPA.

David C. Arnold

Defense Support Program (DSP) and Missile Detection

A space-based system operated by the United States for detecting ICBM launches. The roots of the DSP extend to World War II and branched outward during the following decade. At U.S. Air Force headquarters in the Pentagon during the early 1950s, electrical engineer Joseph Knopow pondered the use of infrared technology for detecting aircraft and submarines. Examining literature captured at the end of World War II, Knopow studied the German Luftwaffe's Kiel IV—a nighttime air-to-air infrared detection system—and considered the possibility of using properly equipped satellites to detect the hot exhaust plumes from ballistic missiles and high-altitude jet aircraft. Shortly after joining Lockheed Aircraft Corporation in June 1995, Knopow convinced his bosses to adopt the infrared-sensing satellite concept, which appeared as Subsystem G of Weapon System 117L (WS-117L) in the March 1956 advanced reconnaissance satellite proposal that Lockheed submitted to the USAF. Meanwhile, Sidney Passman and William Kellogg from the USAF-funded RAND Corporation had written a research memorandum in October 1955 identifying infrared techniques that might be applied to space-based detection of ICBM launches. Their study caught the attention of various science advisory committees and doubtless contributed to the Air Force's selection of Lockheed as prime contractor for WS-117L in June 1956. Knopow became the company's manager for Subsystem G, which he informally dubbed the ICBM Attack Alarm System.

Control of WS-117L and all other military satellite programs shifted to the newly created Advanced Research Projects Agency (ARPA) in March 1958. Although Knopow found himself defending the feasibility of Subsystem G more vigorously than before, the success of experimental payloads aboard aerial test flights in mid-1958 excited Air Force officers. They convinced ARPA officials to separate it from the WS-117L program. On 17 November 1958, the space-based infrared detection system became an independent program identified as the Missile Defense Alarm System (MIDAS). Given the prospect that MIDAS could warn Strategic Air Command (SAC) bomber crews of an impending attack 15 minutes earlier than any other system, Air Force leaders pressed enthusiastically in February 1959 for additional funds to accelerate the program. On 18 September 1959, Secretary of Defense Neil McElroy removed ARPA's oversight and assigned the Air Force direct responsibility for MIDAS.

Although early versions of the development plan had projected an operational space-based warning system by 1962, formidable technical challenges and grossly inadequate funding retarded Lockheed's progress. The first attempt to launch a MIDAS spacecraft failed on 26 February 1960 due to improper separation of the Agena upper stage from the Atlas first stage. After a successful launch of the second MIDAS satellite into a low-inclination, 300-mile orbit on 24 May 1960, problems with the Agena communication link prevented operation of the payload. By August, skepticism on the part of high-ranking Defense Department officials compelled Colonel Quentin Riepe, the first Air Force MIDAS program director, to reorient efforts away from an operational focus toward further developmental and flight tests. Unfortunately, the MIDAS 3 mission on 12 July 1961 terminated prematurely when one of two solar arrays failed to deploy and the satellite ran out of power after only five orbits. An Atlas booster failure on 21 October doomed MIDAS 4. Consequently, on 30 November 1961 a group of experts chaired by ARPA director Jack Ruina recommended to Secretary of Defense Harold Brown that no further consideration be given to an operational system until Lockheed and the Air Force adequately demonstrated the technical feasibility of space-based infrared detection and warning. Hinting at serious program misdirection and mismanagement, the Ruina Report estimated it could take 10 years to achieve an operational version.

Not surprisingly, the MIDAS program was lengthened, wrapped in tighter security restrictions, and renamed Program 461. Disaster continued to plague development efforts in 1962, however, with the loss of MIDAS 5 in April due to a massive onboard power failure on only its sixth orbit, and the destruction of MIDAS 6 in December due to an Atlas launch failure. Shortly after the loss of MIDAS 5, an exhausted Joe Knopow had undergone surgery for a bleeding ulcer, leaving his deputy, John Solvason, to take over program management. Finally, on 9 May 1963 MIDAS 7 successfully achieved a nearly circular 2,250-mile polar orbit. Carrying an improved Aerojet-General infrared payload and a Bouwers concentric telescope with an 8-inch aperture, it detected nine missile launches during 47 days of operation. After yet another launch failure destroyed MIDAS 8 on 12 June, the last satellite with a Program 461 payload—MIDAS 9—went successfully into orbit on 18 July 1963. During its 11-day life span, MIDAS 9 detected one missile as well as some Soviet ground tests. Lockheed and the Air Force had established the feasibility of using infrared-sensing satellites for detection and early warning of ICBM launches.

To support design of the next generation of early warning satellites, the director of defense research and engineering, Harold Brown, on 3 November 1963, approved a three-flight MIDAS research test series for enhancement of longevity and payload reliability. Identified as Research Test Series 1 (RTS-1), these Lockheed satellites had a six-month operational lifetime and carried an improved sensor package produced by Aerojet Corporation for real-time detection and launchpoint determination of low-radiance submarine-launched ballistic missiles and ground-launched, intermediate-range ballistic missiles. The Air Force launched the RTS-1 satellites during 1966, the first on 9 June into an improper, highly elliptical orbit and the others on 19 August and 5 October, respectively, into nearly circular 2,300-mile polar orbits. Their performance far surpassed design standards. Operations continued for a year, capturing data on 139 U.S. and Soviet launches.

Meanwhile, in early 1964 the Air Force had initiated competitive procurement of a follow-on multimission RTS-2 satellite system that would operate in geosynchronous orbit 22,300 miles above the equator. On 15 November 1965, the service redesignated the new system Program 266 (later 949, then 647). Eventually, on 14 June 1969 it would receive the unclassified label of Defense Support Program. Three bidders—Hughes, TRW, and Lockheed—submitted DSP proposals in June 1966. The Air Force awarded TRW the spacecraft contract on 15 December. During the next three and a half years, as TRW worked to deliver the first DSP satellites, the Air Force dispatched survey teams to study possible Large Processing Station (LPS) locations. The United States and Australia signed an agreement in November 1969 to create the Joint Defence Space Communications Station at Nurrungar, near Woomera, which became known as the Overseas Ground Station (OGS). Before the end of June 1970, Buckley Air National Guard Base east of Denver, Colorado, had been selected for the Continental Ground Station (CGS). Those sites, under the direction of Aerospace Defense Command (later Strategic Air Command, then Air Force Space Command), would control the DSP satellites and process in real time all data on missile launches that were transmitted.

The first four launches of DSP satellites, each weighing approximately 2,000 pounds and known collectively as Phase I, occurred during the period 1970–1973. That established an initial operational constellation. Those satellites lasted much longer than their 15-month design life but were replaced with three slightly heavier, more powerful Phase II models during 1975–1977. As the nature of the Soviet missile threat changed, DSP satellites evolved to handle complicated scenarios. Flights 8–11, launched during 1979–1984, had the capability to orbit in either a geosynchronous or highly elliptical path. They also carried external electronic packages for greater survivability, as well as more attitude control system fuel to extend their operational life to three years. Two upgraded Phase II satellites, carrying lead sulfide sensors with improved resolution and new mercury cadmium telluride detectors, entered the picture in December 1984 and November 1987. Finally, in 1989 the on-orbit constellation began to take its present form with introduction of DSP-1 satellites, which weighed more than 5,000 pounds, had a power output more than three times that of the Phase I model, and were designed to last five years.

As DSP satellites improved, the ground segment also evolved to accommodate new mission requirements. Proliferation of ground stations was one way to fulfill a perceived need for greater survivability. Consequently, in December 1974 the Air Force selected IBM Corporation to develop a Simplified Processing Station (SPS). A number of such stations would allow dispersal of receiving capability, as well as backup for the LPSs. During the early 1980s, both OGS and CGS underwent hardware and software upgrades to support future DSP satellite capabilities, and a third fixed site—the European Ground Station—was activated. At the same time, the high cost of the SPS, combined with the perceived need for survivability during and after a nuclear or terrorist attack led the service to acquire a Mobile Ground System (MGS) that became operational in 1985. The latter included six Mobile Ground Terminals (MGTs), along with Mobile Communication Terminals (MCTs) and an MGS Operating Base. Each MGT and MCT had the appearance of an 18-wheel tractor-trailer rig and was entirely roadworthy.

Although the Air Force originally developed DSP to meet a global strategic threat, the system proved its tactical value during Operation DESERT STORM in early 1991. The DSP satellites detected the launch of every Iraqi Scud missile—a total of 88—between 17 January and 25 February. Command centers in Colorado Springs, Colorado, assessed the launch data and provided timely warning to civilians and Coalition forces, including Patriot missile batteries, in Saudi Arabia and Israel. Having demonstrated that the DSP early warning capability worked in the face of theater-level ballistic missile attacks, Air Force Space Command established TALON SHIELD, which officially transitioned to an operational Attack and Launch Early Reporting to Theater (ALERT) capability in September 1994. The ALERT Control Center at Schriever Air Force Base, Colorado, gained responsibility for processing DSP tactical data and warning friendly forces around the globe of potentially hostile launches.

Even as DSP personnel basked in the system's triumphant performance during the Gulf War, Air Force planners struggled to evolve DSP into a far more sophisticated capability—the Space-Based Infrared System (SBIRS)—to support an even broader range of requirements early in the twenty-first century. The complete SBIRS satellite constellation would include sophisticated sensors in geosynchronous, highly elliptical, and low-earth orbits. Among the contractors that teamed up to demonstrate and develop the high and low components of SBIRS were Lockheed Martin, Aerojet, TRW, Boeing, and Raytheon. Alterations in the ground segment would include an SBIRS control station proximate to the old CGS and reduction of overseas sites to Relay Ground Station (RGS) status. In fact, the Nurrungar facility ceased operation in 1999, and a joint U.S.-Australian RGS opened at Pine Gap. A coordinated system-of-systems approach would integrate previously separate space-based infrared sensor programs from the Air Force and national intelligence organizations, thereby eliminating duplication of effort and saving money. Without SBIRS, which would provide critical midcourse tracking and discrimination data, the goals of creating effective theater, national, and global missile defenses would remain illusory.

Rick W. Sturdevant

See also

Missiles, Intercontinental Ballistic; Satellites

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Defense Suppression

Action taken by military forces to reduce the capability of antiaircraft defenses and allow the highest probability of success for friendly air operations. Defense suppression missions emerged during World War I as military forces sought ways to reduce the effectiveness of enemy aircraft in a range of missions, especially ground attack. In World War I, machine guns and heavier weapons used against aircraft became known as antiaircraft artillery (AAA). These defenses were complemented by fighter/interceptor aircraft that operated on standing patrols or were launched upon warning of enemy attack.

Offensive forces attempted to counter defenses through a combination of tactics (e.g., surprise, night operations, or mission profiles) and defense suppression missions. Defense suppression operations normally involved attacks on the defensive positions near the selected target immediately prior to the actual attack. The attacks included strafing and/or bombing, or artillery fire if close to the front, with the intent of either destroying the defensive position or forcing the defenders to abandon their position, thereby preventing them from engaging the attacking aircraft. These basic approaches of tactics, combined with suppressive attacks on defensive positions, remained in effect through the post–Cold War period, although the effectiveness improved with advances in weapons such as cluster bomb units and precision-guided munitions.

As air defenses became more sophisticated, the defense suppression efforts also evolved to meet the challenge. During World War II, the addition of radar for early warning and for controlling AAA fire increased the threat to attacking aircraft. These increased threats were met by new concepts of electronic warfare and the use of chaff—metal strips dropped from the air to reflect any radar beam and thereby hide the location and direction of travel of the threatened aircraft.

After World War II, the sophistication of defensive systems evolved rapidly and included the addition of surface-to-air missiles (SAMs) and improved warning and targeting radars. Air forces developed new combinations of tactics and suppression capabilities to ensure offensive success. During the Cold War, planned defense suppression in front of strategic bomber attacks included nuclear strikes by escort fighters or missiles fired to precede the bombers (e.g., the Hound Dog, SRAM, and air-launched cruise missile). In theater war settings, the ability to attack AAA and SAM sites was improved by the creation of specialized defense suppression systems. Airborne jamming of radar and communications systems—either by standoff (such as the USAF Lockheed EC-130) or escort (such as the USN Grumman E-A6 and USAF General Dynamics EF-111A) platforms—and improved chaff systems degraded both early warning and target tracking radar capabilities. The USAF developed modified fighters (e.g., the Vietnam-era North American F-100D, Republic F-105G, and McDonnell F-4G Wild Weasels) with threat-detection sensor packages and the ability to attack air defense systems with conventional weapons or antiradiation missiles (ARM) that home in on the radar signal (such as the U.S. Shrike and Standard ARM and later the HARM and the British ALARM).

Late in the Cold War, the much improved AAA and SAM threats and enhanced detection, warning, and tracking capabilities were melded with ground-directed interceptors and complex command and control systems to create integrated air defense systems (IADS), which presented serious challenges for attacking air forces. But an enemy IADS could be successfully attacked based on good intelligence, careful planning, and disruptive attacks on key points in the system, followed by the skillful application of traditional tactical and technical responses to individual air defense threats. The opening phase of Operation DESERT STORM involved the successful disruption of the Iraqi IADS followed by aggressive offensive counter air attacks and continuous tactical adjustments and ongoing defense suppression missions, resulting in minimal Coalition losses throughout the campaign.

Jerome V. Martin

See also

Air Superiority; Defense Suppression; DESERT STORM; Electronic Warfare; Missiles; Tactical Air Warfare

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DELIBERATE FORCE (1995)

NATO code name for peacemaking air campaign in Bosnia-Herzegovina under the command of USAF Lieutenant General Michael E. Ryan. Operation DELIBERATE FORCE was the first NATO military campaign in alliance history and was designed to force the Bosnian Serb army to cease shelling UN-designated "safe areas" throughout Bosnia. In concert with other events of late 1995, DELIBERATE FORCE played a decisive role in bringing the Bosnian Serbs to the negotiating table and ending three years of civil war in Bosnia-Herzegovina.

DELIBERATE FORCE received its mandate from Operation DENY FLIGHT, an air operation approved by UN Security Council Resolution 816 on 12 April 1993 to protect UN peacekeepers. After several Bosnian-Serb actions in July-August 1995, UN and NATO leaders concluded the piecemeal nature of DENY FLIGHT was ineffective and began planning an air campaign to protect UN safe havens in Gorazde and Sarajevo. NATO made the decision to begin the bombing 48 hours after a mortar attack against a Sarajevo market killed 37 civilians on 28 August.

The UN/NATO Joint Targeting Board approved 87 targets for DELIBERATE FORCE, including integrated air defense systems, fielded heavy weapons, supply and munitions depots, command and control relay sites, and key lines of communications for the Bosnian Serb Army. DELIBERATE FORCE involved 15 nations flying 3,535 sorties and 1,026 munitions expenditures, 70 percent of which were precision-guided. More than 400 hundred aircraft, including 222 fighters, were poised at 18 air bases across Europe for the operation. The operation was complemented by U.S. Tomahawk missile strikes and Predator unmanned aerial vehicles.

Although DELIBERATE FORCE spanned only 16 days of bombing, it was decisive in ending the civil war in Bosnia. Along with a successful Bosniak-Croat Federation ground campaign and an aggressive U.S. diplomatic strategy, DELIBERATE FORCE paved the way for eventual peace talks in Dayton, Ohio, in December 1995.

Mark D. Witzel

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Deptula, David A. (1952–)

USAF general. David Albin Deptula was born in Dayton, Ohio, on 11 June 1952. He earned a bachelor's degree (1974) and master's degree (1976) from the University of Virginia and, in 1994, a master's degree in national security strategy from the National War College. A distinguished graduate of the Air Force Reserve Officer Training Corps program, he completed pilot training in early 1977.

He has taken part in air operations, defense planning, and joint warfighting from unit to unified command and service headquarters levels, in addition to serving on two congressional commissions charged with outlining the nation's future defense needs. His aviation career includes more than 3,000 flying hours (more than 400 combat) in operational fighter and training assignments. He is a graduate of the USAF Fighter Weapons School and has served as an operational instructor pilot, F-15 aerial demonstration pilot, commander of an F-15 operations group, and commander of a joint and combined task force. In August 1990, he participated in the original design of the Coalition air campaign against Iraq.

During Operation DESERT STORM he was the principal offensive air campaign planner for the Joint Force Air Component Commander. As the commanding general, Joint/Combined Task Force Operation Northern Watch (1998/1999), he flew more than 80 combat missions leading a coalition of Turkish, British, and U.S. forces in enforcing the no-fly zone over northern Iraq. He has served in a variety of staff positions, including legislative liaison for the Air Staff's War Fighting Concepts Development Division and on the Secretary of the Air Force's policy group, where he was a principal author of the white paper *The Air Force and U.S. National Security: Global Reach—Global Power.*

More recently he has served on the 1994 Commission on Roles and Missions, as the Air Force representative to the 1997 National Defense Panel, as director, Expeditionary Aerospace Force Implementation, and as director, Air Force Quadrennial Defense Review (2001). Among his many awards and decorations is America's highest peacetime award, the Defense Distinguished Service Medal.

John Andreas Olsen

See also

DESERT STORM; INSTANT THUNDER

DESERT FOX (1998)

Code name for post–Gulf War air campaign against Iraq to thwart its capability to produce weapons of mass destruction. At the end of the Gulf War of 1991, the United Nations Security Council demanded that Iraq fully disclose and dismantle its program to build biological, chemical, and nuclear weapons and the missiles to deliver them. By December 1998, the United Nations Special Commission concluded that Iraq had not met those requirements, and as diplomatic efforts failed to solve the ongoing inspection problems, the U.S. and British governments decided to resolve the crisis by the use of military force. Operation DESERT FOX sought to strike military and security targets in Iraq that were contributing to Iraq's ability to produce, store, maintain, and deliver weapons of mass destruction.

The declared objectives were "to degrade Saddam Hussein's ability to make and use weapons of mass destruction, to diminish his ability to wage war against his neighbors, and to demonstrate the consequences of flouting international obligations." The combined air strikes lasted four nights (16–19 December 1998), ending as the Muslim holy month of Ramadan started. The United States and the United Kingdom suffered no losses; Iraqi casualty figures remain unknown. Approximately 600 sorties and 400 cruise missiles were launched against some 100 targets in the lowland areas between the Tigris and Euphrates Rivers from Tikrit in the north to the southern port city of Basra. The key targets were suspected weapons production sites, air defense systems, command and control facilities, Republican Guard bases, and other presidential elite units.

In military terms, Operation DESERT FOX is regarded as a success: The bomb-damage assessment indicates that smart bombs and improved cruise missiles resulted in one of the most accurate bombing campaigns in the history of warfare. The political effects of the air campaign are disputed. U.S. and British leaders claimed that the air strikes achieved their mission, whereas others speculate that Saddam Hussein succeeded in weakening the cohesion of the 1991 Coalition and halting UN inspections (such inspection operations have yet to resume). Considered together with the no-fly zones and UN-imposed economic sanctions against Iraq throughout the 1990s, Operation DESERT FOX represented the culmination of tension between Iraq and the United Nations in the aftermath of Operation DESERT STORM.

John Andreas Olsen

See also

DESERT STORM; Iraqi Air Force

DESERT SHIELD (1990)

Operation by the U.S. military and the international Coalition to deter further Iraqi aggression and, if necessary, defend Saudi Arabia during the Gulf War. The operation was originally known as PENINSULA SHIELD. On 2 August 1990, six divisions of the elite Iraqi Republican Guard Corps invaded Kuwait. Five days later, U.S. military forces started deploying to Saudi Arabia to establish a credible deterrence capability.

Airpower played an important role in DESERT SHIELD. The first two service branches able to move assets to the Persian Gulf were the U.S. Navy and Air Force. Aircraft from U.S. carriers and elements of the 1st Tactical Fighter Wing, which began arriving on 8 August, were the first credible military assets ready to defend Saudi Arabia.

By 2 September, the United States had approximately 600 aircraft in place. With the necessary assets, U.S. Air Force Lieutenant General Charles Horner began to create a plan to integrate the various types of aircraft into a coherent strike force.

During this time, high-level U.S. military leaders were debating strategy for the possible air war. Air Force planners put together a strategic bombing concept that was intended to destroy Baghdad's command and control, critical "centers of gravity" (petroleum and electrical targets), and the country's infrastructure in order to cripple Iraq's ability to wage war.

Airpower enthusiasts thought the plan to be exactly what was needed to keep Coalition casualties to a minimum. Others in the military hierarchy were not so supportive. It would not be until DESERT STORM that the debate would be resolved.

Craig T. Cobane

See also
DESERT STORM; Horner, Charles A.; Strategic Bombing

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DESERT STORM (1991)

International military operation undertaken in early 1991 to expel Iraqi forces from Kuwait; the offensive portion of the Gulf War. Airpower played a vital role in deterring Iraq during Operation DESERT SHIELD, paving the way for one of the most decisive military victories in history. Many analysts believe that the Gulf War was the first in history to be decided by airpower.

DESERT STORM can be divided into two phases: the air war and the ground war. The Coalition strategy was to take advantage of its superior airpower. On 17 January, the air war began when a flight of U.S. Apache helicopters destroyed early warning radar installations, allowing U.S. F-117 stealth aircraft, using laser-guided bombs, to cripple Iraq's sophisticated air defense system.

Early in the war, the Coalition's air superiority became clear. Iraq possessed nearly 800 combat aircraft and an integrated air defense system controlling more than 3,000 surface-to-air missiles. Due to Coalition air supremacy, however, Iraq was unable to win a single air-to-air engagement and lost 35 aircraft (total Iraqi losses exceeded 200 aircraft).

The air war continued for five weeks, with more than 109,000 combat sorties (40,000 against Iraqi ground forces). The Coalition lost only 38 aircraft—the lowest loss rate of any air combat in history and less than the normal accident rate per sortie in combat training. By the cease-fire, Coalition airplanes had dropped 88,500 tons of ordnance (6,500 tons precision-guided). As the air phase of the war ended, it was clear that Coalition airpower had significantly degraded Iraq's military capability.

Craig T. Cobane

See also
DESERT SHIELD; Horner, Charles A.

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Dewoitine Aircraft

Emile Dewoitine (1892–1979), innovative engineer, designed an all-metal parasol fighter in 1919. The D.1 flew in 1922 and was bought in quantity by the French services and Serbia; Italy produced 120 units under license. After improvements, the second-generation D.27 arrived in 1927 and was selected by Yugoslavia, Switzerland, and France, which also bought the D.53 derivative. Launched in 1932, the D.500 series was a success in France, with 350 fighters built. The D.370 and its derivatives were a step backward as the last parasol fighters, their production reaching only 87 units. The Dewoitine D.520, a modern design that flew in October 1938, became the best French fighter of its time. Only 403 examples had been accepted before France collapsed in June 1940. As good as the German fighters, they were not in a sufficient number to play a decisive role. More were built for occupied France. After the war, Emile Dewoitine was accused of active collaboration. He never built aircraft in France again, but he did assist in designs in Argentina.

Stéphane Nicolaou

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Dien Bien Phu, Battle of (1954)

Viet Minh victory at Dien Bien Phu in 1954, the first achieved by a Third World nationalist uprising against a great colonialist power like France. Located near the Laotian border, Dien Bien Phu had been selected to change from a moving to static war. The reinforcement started on 20 November 1953. Air transportation was the only way of access, first by dropping parachutists, then by using a former Japanese landing strip.

The Viet Minh placed 130,000 men and a quantity of artillery without being detected by French aerial reconnaissance. The siege began on 13 March 1954, and the Vietnamese immediately overran several strong points where they put antiaircraft artillery, limiting the strip to night use only.

The tactical pilots of the Aéronavale (the French naval air force) fought bravely when morale was low among Armée de l'Air crews, but the transporters proved to be equally important. Their task was vital for the troops, as all support was coming from the air. Bombing missions were mainly against antiaircraft artillery to make C-47 and C-119 drops less dangerous. The United States, fearing a Chinese reaction, rejected the French plea for B-29 bombing. On 7 May 1954, the last defenders surrendered. Dien Bien Phu showed that aerial weaponry by itself couldn't secure a victory—a lesson U.S. politicians forgot 10 years later in Vietnam.

Stéphane Nicolaou

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Dieppe, Battle of (1942)

First major European amphibious operation of World War II. On 19 August 1942, a landing force of 5,000 Canadian and 1,000 British troops, plus a token force of 60 U.S. Army Rangers, raided the German-held French channel port of Dieppe. The raid was launched because the Allies needed to demonstrate to the people of occupied Europe that they could mount an operation against the Germans, who had marched unimpeded across Europe. Additionally, the raid would provide needed experience in modern landing techniques.

Operation JUBILEE, as the raid was called, ran into trouble early when the approaching assault boats were discovered and fired on by five armed German trawlers. All hope for surprise was lost as the German defenders established a deadly crossfire on the beach in the predawn darkness.

By 9 A.M., the beachhead was a site of carnage, and British commanders decided to withdraw the surviving troops. Allied destroyers escorted rescue boats under murderous German fire to pull out the survivors.

By early afternoon, the rescue boats were headed back to England with the remnants of the Dieppe raiders, leaving 24 officers and 3,164 men behind, killed or captured. Of the 5,000 Canadian troops, some 900 were dead and almost 2,000 captured.

James H. Willbanks

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Distant Early Warning (DEW)

A series of radar installations, stretching just above the Arctic Circle from Alaska across Canada to Greenland, designed to give early warning of attacks from air and space on North America. Construction of the DEW Line was initially approved by President Harry Truman in late 1952. Despite a contentious public debate throughout 1953 and 1954, testing and construction commenced, and the initial network of 57 sites became operational during the summer of 1957.

Construction was funded by the United States and carried out under extremely harsh Arctic conditions by U.S. and Canadian contractors. Duty for the U.S. civilian and military personnel manning DEW installations was both arduous and tedious. In theory they would provide the first warning of any Soviet attack coming in over the Arctic Ocean, then relay that information to the Combat Operations Center, North American Air Defense Command, in Colorado Springs, Colorado. The Air Force hoped that the resulting 3–6 hours of warning would allow them to scramble air defenses to intercept Soviet bombers and, more important, allow the bombers of the Strategic Air Command to be dispersed and protected from attack.

The DEW Line evolved throughout the rest of the Cold War to match the changing threat. The number of DEW sites peaked at 78 in the early 1960s, by which time it was supplemented not only by the Mid-Canada and Pinetree radar networks that had preceded it to the south but also by seaward extensions of radar coverage provided by a variety of permanent radar platforms (so-called Texas Towers), naval picket ships, and early warning aircraft. As the threat from intercontinental ballistic missiles slowly eclipsed that of bombers throughout the 1960s, most of these supplementary systems were gradually decommissioned, but the DEW Line continued in service for the duration of the Cold War. From the late 1980s through the mid-1990s, it was gradually replaced by the North Warning System, build largely on old DEW sites.

David Rezelman

See also

Air Defense Command; Antimissile Defense; Ballistic Missile Early Warning System; Cold War; Missiles, Intercontinental Ballistic; North American Air Defense Command; Radar; Satellites; Soviet Aircraft Development and Production; Sputnik; Strategic Air Command; Strategic Defense Initiative

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The great Jimmy Doolittle, sitting on the edge of the cockpit of his Wedell Williams racer. (Walter J. Boyne)

Doolittle, James H. (1896–1993)

Pioneer American aviator, engineer, scientist, and military officer; his career spanned aviation's first century. He spent his early childhood in Nome, Alaska, while his father prospected for gold. Educated in Southern California, he was an excellent amateur boxer and at times fought for money.

When the United States entered World War I, Doolittle enlisted as a flying cadet in the Signal Corps Reserve, attended flying school, and soloed after 7 hours and 4 minutes of flight instruction. After commissioning as a second lieutenant, he served as a flight gunnery instructor at Rockwell Field in San Diego, California. His request and hope for an overseas assignment to the war zone were denied because of the Armistice of November 1918.

Following the war, he had several flying assignments and received some excellent hands-on engine and airplane construction experience from several superb instructors at Kelly Field, Texas. In September 1922, he made a cross-country flight in an elapsed time of 22 hours and 30 minutes, a feat that gained him instant notoriety.

Doolittle spent the next several years in academia, earning a bachelor's degree from the University of California and a master's and a Ph.D. from the Massachusetts Institute of Technology. In 1925, he won the Schneider Trophy for testing a Curtiss R3C-2 float biplane, bettering both domestic and international competitors at an average speed of 232.573 mph over a straightaway course. At the age of 28, James Doolittle was considered the most qualified, most experienced, and best-educated test pilot in the United States.

Taking several leaves of absence from the Army, Doolittle flew many dangerous demonstration flights for various U.S. aviation companies while working on flight instrumentation and blind flying at Mitchell Field's Full Flight Laboratory in New York. On 24 September 1929, he made a flight using the Kollsman precision altimeter, the Sperry gyrocompass, the Sperry artificial horizon, and rudimentary radio navigation aids. Besides piloting the historic flight, Doolittle had much to do with the aircraft's engineering, offering suggestions to the contractors, helping them refine their thinking and improve their designs, and furnishing them with vital input from a cockpit perspective.

In February 1930, Doolittle decided for personal financial reasons to resign from the Air Corps to work for Shell Petroleum Corporation, where he coordinated the company's aviation departments in San Francisco, St. Louis, and New York. In addition, he kept the company in the public's eye by continuing to participate in air shows and races.

In January 1940, he was appointed president of the Institute of Aeronautical Sciences, one of the most prestigious and influential technical societies in the world, but this was not satisfying enough. Doolittle wanted to be in the action, and he requested recall to active duty. On 1 July 1940, he returned to active-duty status, went to Great Britain on an inspection tour, and tested new aircraft like the B-26 Marauder.

In early 1942, the United States, still tormented by the shock of Pearl Harbor and the continuing succession of Japanese victories, needed some type of victory to raise morale. General Henry H. "Hap" Arnold, the commanding general of the Army Air Forces, chose Doolittle to lead an air strike of Army B-25 bombers from the Navy aircraft carrier *Hornet* against the Japanese mainland. On the morning of 18 April 1942, the Japanese observed the carriers *Hornet* and *Enterprise,* compelling higher command to schedule the raid a day earlier. All 16 B-25s dropped their bombs, but as a consequence of the 150-mile extended flight path all but one aircraft, which landed in the Soviet Union, ran out of fuel and went down in Japanese-occupied China. Most of the pilots, including Doolittle, maneuvered their way to friendly lines. Although the damage from the Doolittle Raid was slight, the psychological effect on the Japanese was significant: Imperial forces had failed to protect the homeland. Doolittle was made a brigadier general following the raid and received the Congressional Medal of Honor. Promotion to major general soon followed.

He went to Europe to command the 4th Bombardment Wing (Medium) of the Eighth Air Force and subsequently the Twelfth Air Force for the invasion of French North Africa, before commanding the Northwest African Strategic Air Forces (NASAF). As NASAF commander, his forces concentrated on Axis logistics and supply. Doolittle flew at least a half-dozen combat missions during this period.

During his stint in the Mediterranean theater, Doolittle underwent a crash course in large-scale military administration. He introduced imaginative new fighter tactics by encouraging his fighters to employ loose escort, instead of close escort, of bomber formations. On 6 January 1944, Doolittle assumed command of the mighty Eighth Air Force, the largest and most prestigious air force, with no fewer than 26 heavy bomber groups, 12 fighter groups, 42,000 combat aircraft, and 150,000 personnel. He again changed the role of his fighters from escort to killer, allowing his fighters to chase German fighters instead of waiting for the enemy to come to them.

After V-E Day, Doolittle moved his Eighth Air Force to the Pacific, where he was present for the unconditional Japanese surrender aboard the battleship *Missouri* on 2 September 1945. Following the war, he worked hard to promote a separate U.S. Air Force through speech-making and congressional testimony. He was a founder of the Air Force Association and its first president. He left active duty but remained in the Air Force Reserve until retiring as a lieutenant general in 1959. After leaving active duty, he returned to his position at Shell as a vice president and director, holding that position until 1967. In 1985, President Ronald Reagan and Senator Barry Goldwater pinned on his fourth star, promoting him to full general.

Known as the master of the calculated risk, this scientist-aviator and man of many talents and accomplishments died peacefully in his sleep on 27 September 1993, at the age of 96. The Air Force gave him a full-honors funeral and an elaborate ceremony reserved for dignitaries and top officers that included a 21-gun salute and a flyover by 11 aircraft.

George M. Watson Jr.

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Dornier Aircraft

Claude Dornier (1884–1969) began his aviation career with the Zeppelin Airship Company in 1910. From 1915 to 1918, he directed manufacture of several all-metal aircraft, including large flying boats.

Prohibited by the victorious Western allies from making aircraft in Germany after World War I, Dornier moved work to Switzerland and Italy and initiated manufacture of the Wal (Whale) flying boats, which pioneered mail and passenger services in the 1920s and 1930s; more than 260 were made. The huge 12-engine Do X flying boat of 1929 undertook a four-continent tour in 1931.

The Do17 Flying Pencil and the Do 24 (more than 200 were made and in service in some countries until the 1970s) and Do 26 flying boats developed for Lufthansa Airlines saw extensive military work in World War II. Dornier also manufactured products of other firms. The Do 335 twin-engine fighter-bomber, at 450 mph, was one of the fastest wartime aircraft, though few were built before the war ended.

Having undertaken other manufacturing after 1945, Dornier resumed civil and training aircraft manufacture a decade later. The company was taken over by Daimler Benz in 1985.

Christopher H. Sterling

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Dornier Do 217

German twin-engine bomber and night-fighter during World War II. Dornier designed the Do 217 as a successor to the Do 17. Design began in 1937, a prototype flew in 1938, and 1,541 bombers and 364 night-fighters served from 1940 to 1945.

Do 217s were initially envisioned as dive-bombers, and technical difficulties delayed the program until this requirement was waived. Twelve preproduction Do 217A/Cs began clandestine reconnaissance of the Soviet Union in late 1940. At that time, Do 217Es commenced level-bombing, reconnaissance, and antishipping tasks. After initial operational experience, one 20mm cannon, two machine guns (for a total of seven), and cockpit armor plating were added. By late 1941, 300 Do 217Es were flying antishipping missions from the Netherlands, where they remained until late 1944. At 17,000 feet cruising altitude, Do 217Es carried 8,818 pounds of bombs at 258 mph for 1,430 miles.

Do 217J night-fighters were Do 217Es with four additional 20mm cannons, four machine guns, and a Liechtenstein radar in the nose. Do 217N night-fighters were Do 217Js modified with Schräge Musik (jazz music): two (later four) 20mm cannons mounted in the fuselage at a 70-degree angle to fire upward into the unprotected bellies of enemy bombers. Some Do 217Ns received Flensburg and Naxos devices that homed on to emissions from British bombers. Do 217J/Ns operated from May 1943 until mid-1944.

Do 217K/M night-bombers employed Fritz-X radio-guided bombs and Hs 293A wire-guided bombs to attack Allied shipping in the Mediterranean and Bay of Biscay in late 1943. They sank or seriously damaged three battleships, three cruisers, and several destroyers. Three Do 217P high-altitude (43,960-feet) reconnaissance aircraft and five Do 217R guided-bomb carriers never saw active service.

James D. Perry

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Douglas, William Sholto (1893–1970)

Held several high offices in the Royal Air Force during World War II and in commercial aviation in the postwar period. William Sholto Douglas, later Lord Douglas of Kirtleside, joined the Royal Flying Corps in 1914, having learned to fly before the war. He served in a reconnaissance squadron, flying the BE.2a, and rose to command Nos. 43 and 44 Fighter Squadrons. He became an ace, with five German aircraft shot down.

After the war, he became chief test pilot for Handley Page (and held commercial license number four), then returned to the RAF to command forces in the Sudan. Douglas became head of Fighter Command in 1940 on the retirement of Hugh Dowding. He moved on to head the RAF in the Middle East in 1943, then commanded Coastal Command from 1944 to 1945.

After serving as military governor of the British zone of occupation in Germany after the war, he became a director of British Overseas Airways Corporation, one of the two state-owned airlines, and finally served for 15 years as chairman of the other, British European Airways (1949–1964).

Christopher H. Sterling

See also

Britain, Battle of; Dowding, Hugh C.T.

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Douglas A-4 Skyhawk

Often called "Heinemann's Hot Rod," after the Douglas chief engineer Edward Henry Heinemann. The diminutive A-4 served as the primary U.S. Navy light attack aircraft for nearly 30 years. The design originated in 1952 when the Navy asked for the minimal aircraft that could deliver a tactical nuclear weapon. The A-4 (originally designated A4D-1) designed by Heinemann was less than 40 feet long, spanned less than 28 feet, and only weighed 8,500 pounds empty. The wing was so small that it did not require folding during carrier storage. The XA4D-1 made its first flight on 22 June 1954, and operational A4D-1s were accepted beginning in August 1954.

The A-4 was heavily involved in bombing missions in Southeast Asia, although it was limited to daytime operations in relatively good weather. The first A-4 strike against Vietnam was on 5 August 1964, with the last occurring on 28 June 1973. Eventually, 2,960 A-4s of all types would be manufactured, with the last being delivered on 27 February 1979. This included 555 two-seat trainers, a type that would not be retired until 20 October 1999.

The Blue Angels aerobatic team flew A-4s from 1974 to 1986, and a few TA-4J Skyhawks equipped with special electronics gear are expected to remain in service with the U.S. Navy until 2004. The A-4 proved to be popular with operators other than the United States, mainly because it was inexpensive to acquire and operate and was still a relatively capable daylight attack aircraft. In addition to the U.S. Navy and Marines, Argentina, Australia, Brazil, Indonesia, Kuwait, Malaysia, New Zealand, and Singapore operated the type.

Dennis R. Jenkins

Popular around the world because of its low price tag and ease of operation, the Douglas Skyhawk served as the primary U.S. Navy light attack aircraft for nearly 30 years. (Walter J. Boyne)

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Douglas A-20 Havoc

Douglas Aircraft developed the Model 7B twin-engine light attack bomber in the spring of 1936. The prototype flew for the first time in October 1938. However, due to budget constraints U.S. Army Air Corps officials decided not to purchase the aircraft.

French officials had no such hesitation. In 1939, they ordered 270 of what was now designated the DB-7. Belgium also ordered an unspecified number. When France fell to Germany in 1940, the DB-7s as well as remodeled DB-7As and Bs were shipped instead to Great Britain and redesignated the Boston I, II, and III.

Ironically, Air Corps leaders had already changed their minds by late 1939 following the passage of the bountiful Military Appropriations Act of April 1939. They ordered 63 DB-7s as high-altitude attack bombers with turbosupercharged Wright Cyclone radial engines. The Air Corps redesignated this aircraft the A-20.

After initial flights of the aircraft, the Air Corps decided it did not need a high-altitude light attack bomber but rather a low-altitude medium attack aircraft. To this end, only one A-20 was built and delivered. The final 62 contracted aircraft were built as P-70 night-fighters, A-20A medium attack aircraft, or F-3 reconnaissance aircraft. The lone A-20 was used later as a prototype XP-70 for the development of the P-70 night-fighter version of the Havoc.

Construction of the A-20A, the first production model, began in early 1940. By April 1941, 143 had been built and delivered to the 3d Bomb Group (Light; 3BG). The aircraft was 47 feet, 7 inches long with a wingspan of 61 feet, 4 inches. It had a gross takeoff weight of 20,711 pounds. Powered by two Wright R-2600-3 or -11 Cyclone radial engines producing 1,600 hp, it had a maximum speed of 347 mph, a cruising speed of 295 mph, and a maximum ferry range of 1,000 miles. It had nine .30-caliber machine guns: four forward-firing in a fuselage blister, two in a flexible dorsal position, one in a ventral position, and two rear-firing guns in the engine nacelles. It had a maximum bombload of 1,600 pounds.

In October 1940, Douglas and Air Corps officials concluded a contract for 999 B models. Although it used the same Wright 2600-11 engines as the last 20 -A models, it was lighter and armed like the DB-7A. The A-20B had two .50-caliber machine guns in the nose and only one .50-caliber gun in the dorsal mount. Its fuselage was 5 inches longer; it had a 2,400-pound maximum bombload, a maximum speed of 350 mph, a cruising speed of 278 mph, and a 2,300-mile ferry range. Eight were sent to the Navy as DB-2 target-towing aircraft, and 665 were delivered to the Soviet Union as Lend-Lease aircraft.

Douglas built 948 C models, 808 at the Douglas plant in Santa Monica, California, and 140 under contract at the Boeing plant in Seattle, Washington. The C was patterned after the A model. Its Wright R-2600-23 Cyclone radial engines provided this heavier aircraft a maximum speed of 342 mph. Like all Havoc models, it had four crew members—a pilot, navigator, bombardier, and gunner. Originally built to be Royal Air Force and Soviet Lend-Lease aircraft, the Cs were diverted to the U.S. Army Air Forces once the United States entered World War II.

More G models were produced than any other A-20 version. Douglas built 2,850 in 45 block runs. The major differences were new and varying armaments, most notably the addition of four forward firing 20mm cannons in the nose. After block run number five, these were again replaced with six .50-caliber machine guns.

Douglas built 412 H models, 450 J models, and 413 K models. They were heavier at 2,700 pounds and had Wright R-2600-29 Cyclone supercharged radial engines producing 1,700 hp and flying at 339 mph. They carried 2,000 pounds of bombs internally and 2,000 externally.

A-20 production ended in September 1944. Douglas and other plants built 7,230 A-20s. They served in every theater of war and with the USAAF, the RAF, as well as the Australian, Soviet, and several other Allied air forces. More A-20s were built than any other attack-designated aircraft to serve in World War II.

William Head and Brian Head

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Douglas A/B-26 Invader

In June 1941, Douglas Aircraft contracted with the U.S. Army Air Corps to produce two prototype twin-engine medium attack aircraft to replace the Douglas A-20 Havoc—the XA-26 attack version, and the XA-26A night-fighter, which was later canceled in favor of the Northrop P-61.

The XA-26 first flew on 10 July 1942 and was accepted by the U.S. Army Air Forces on 21 February 1944. It had twin Pratt and Whitney R-2800-27 radial engines producing 2,000 hp each. It was 51 feet, 2 inches long with a wingspan of 70 feet. Its gross weight was 31,000 pounds and had a maximum bombload of 5,000 pounds. Its maximum speed was 370 mph, its cruising speed 212 mph, and it had a range of 2,500 miles. It had a crew of three, a clear nose structure, two forward-firing .50-caliber machine guns, and two aft barbettes (dorsal and ventral).

As testing continued, the USAAF ordered a third prototype designated the XA-26B that featured a solid nose. After numerous experiments with various nose armaments, the early production A-26Bs had six .50-caliber machine guns, and later Bs had eight guns mounted in the nose.

The first production model was the A-26B. Douglas built them at Long Beach, California, and Tulsa, Oklahoma, delivering 1,355 from 1943 to 1945. The production model was similar to the prototypes, except it carried 6,000 pounds of bombs, could reach a maximum speed of 355 mph, cruise at 284 mph, and had a range of 3,200 miles. Deliveries began in August 1943. The first B models saw combat on 19 November 1944. In 1945, Douglas made minor armament and engine changes to the A-26, and later production models were designated A-26C. Once in combat, all 2,502 A-26B/Cs produced by the time contract ended in the mid-1945 used the nickname Invader.

The B models remained in service after the war, and in 1948 the U.S. Air Force dropped the attack designation and redesignated them the B-26. During the Korean War (July 1950–July 1953), between 90 and 111 B-26s stationed in Japan flew nearly 70,000 sorties, dropping nearly 100,000 tons of bombs on enemy targets.

The B models were also converted into CB-26B cargo transports, TB-26B trainers, VB-26B staff transports, DB-26Bs (which towed the Ryan Q-2A Firebee drone), the EB-26B Wingless Wonder drag parachute test aircraft, and the RB-26B reconnaissance aircraft. Some flew until the 1970s.

In the early 1960s, the Air Force, realizing the advantages of the B-26 design in reconnaissance and counterinsurgency roles, employed B models in Vietnam. Crashes due to structural failure forced the Bs to be retired. To fill the void, a B-26C (S/N 44-35684) was modified with Pratt and Whitney R2800-103W engines, larger propellers, and a 8,000-pound bombload. It was designated the YB-26K Counter Invader.

The test program was so successful that the Air Force ordered 40 modified B-26Ks. On Mark Engineering Company produced the K models in 1963 and 1964. They first saw combat in 1966. Based in Thailand, they proved highly effective flying interdiction and counterinsurgency missions over the Laotian Panhandle in support of Operation STEEL TIGER. Since the Thai government restricted the number of bombers using Thailand's bases, the Air Force redesignated the Ks A-26As.

Throughout three major wars, the Douglas A/B-26 models performed their various roles effectively. Whether as an attack aircraft, medium bomber, or light bomber, they were

Although bought out by McDonnell Aircraft in 1967, the Douglas Aircraft Company was one of the top airplane manufacturers in the United States, producing such influential designs as the Douglas Havoc. (Douglas Aircraft Company, Inc.)

one of the longest-serving and best aircraft in U.S. Air Force history.

William Head

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Douglas Aircraft

U.S. aircraft manufacturer. For seven decades, the Douglas Aircraft Company produced 80 types, fully nine generations of successful commercial aircraft. Donald Douglas graduated from the Massachusetts Institute of Technology in 1915 and remained for a year as an assistant instructor in aeronautical engineering.

After Douglas left MIT, he went to the Connecticut Aircraft Company, where he worked on the first Navy dirigible, the DN-1, and then briefly for the Glenn Martin Company. In 1918, he went to work for the U.S. Army Signal Corps. He went back to Martin briefly and designed the Martin MB-1 bomber.

In 1920, he moved to Santa Monica, California, invested his entire savings of $600, and formed his first company (Davis Douglas Company), with 18 square feet of desk space in the rear of a barbershop. His first aircraft design was a large, two-place wood-and-fabric biplane called the "Cloudster." The first flight was on 24 February 1921, becoming the first aircraft to lift off the ground with a combination of payload and fuel equal to its own empty weight.

Douglas reformed his company in 1921 as the Douglas Company (in 1928 it became the Douglas Aircraft Company); Douglas served as president until 1957, when he became chairman and chief executive officer.

On 6 April 1924, four Douglas "World Cruisers" took off for the first successful round-the-world flight. Many civil and military developments of the World Cruiser followed.

On 17 December 1935, the Douglas DC-3 made its first flight, and no single aircraft has influenced air transportation as much since. Some historians regard it as the most important transport aircraft ever built. The DC-3 was the first commercial aircraft that could make money carrying passengers alone, without a mail subsidy. In the United States between 1935 and 1985, at least 355 civilian airlines and corporations used DC-3s; this does not take into account all the individual private owners. The DC-3 became the C-47 in military service.

By 1944, Douglas was the fourth largest aircraft company in the United States. It had six factories in three states, 160,000 employees, and a payroll of $400 million. It produced the SBDA-20 and A-26 and built B-17s for Boeing.

Through a series of strategic miscalculations on the part of the Douglas company, Boeing fielded the first commercial passenger jet—the 707. Douglas followed up with the DC-8, but this led to a decline in profits, despite its marketing of many successful military designs, including the A-4.

The McDonnell Aircraft Company acquired Douglas in 1967, becoming McDonnell Douglas. The 1990s saw an additional decline in sales and profits. In 1998, Boeing acquired the McDonnell Douglas Corporation.

Henry M. Holden

See also

Douglas World Cruiser; Douglas A/B-26 Invader; Douglas A-20 Havoc; Douglas C-47 Transport; Douglas SBD Dauntless

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Douglas C-47 Transport

Ranked as one of the five most important pieces of equipment assisting in the Allied victory in Europe in World War II by General Dwight D. Eisenhower, commanding general of the Allied forces in Europe.

The C-47 was one of more than 50 variants of the Douglas DC-3. It was used mainly as an ambulance and transport aircraft. The C-47 was the primary aircraft used for every paratroop invasion during World War II. During that war, the C-47 carried 22 million tons of goods and flew 67 million passenger-miles. It was responsible for the evacuation of more than 750,000 wounded.

The total military variants of the DC-3/C-47 were 10,291, or 96.79 percent of DC-3 production (10,632 total). Additionally, 487 Japanese variants and 6,157 Russian Li-2s were manufactured from the Douglas plans, bringing the grand total for the type to 17,276. It was nicknamed the "Gooney Bird" and the "Dakota."

Henry M. Holden

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Douglas D-558

U.S. research plane; significant because it helped to provide design data for future transonic and supersonic aircraft with both straight and swept wings. The D-558 flight research

The Douglas C-47 was one of the most important airplanes in World War II, used primarily for transport and evacuation. (Walter J. Boyne) program, carried out in a partnership between Douglas Aircraft, the U.S. Navy, and the National Advisory Committee for Aeronautics at the High-Speed Flight Research Station at Edwards Air Force Base, California, was divided into two phases, each having three aircraft.

A single-place straight-wing jet-powered aircraft—the D-558-1 Skystreak—was manufactured by Douglas Aircraft and designed to investigate jet aircraft characteristics at transonic speeds, including stability and control and buffet. Unlike the Bell XS-1 (X-1), it took off and landed under its own power.

The first flight of the aircraft was on 14 April 1947, with Gene May as the Douglas test pilot. Its maximum speed of 650.8 mph, then a world record for turbojet-powered aircraft, was achieved by U.S. Marine Corps Major Marion Carl on 25 August 1947. The three D-558-2 Skyrockets had the mission to investigate flight characteristics of a swept-wing aircraft at high supersonic speeds, with particular attention to the problem of pitch-up, a phenomenon often encountered with swept-wing aircraft.

The first of the D-558-2s had a Westinghouse J34-40 jet engine and took off under its own power. The second was equipped with a turbojet engine, replaced in 1950 with a Reaction Motors LR8-RM-6 rocket engine. This aircraft was modified so it could be air-launched from a P2B-1S (a Navy B-29) carrier aircraft. The third Skyrocket had jet and rocket engines and could be air-launched.

The D-558-2 was first flown on 4 February 1948 by Douglas test pilot John Martin. National Advisory Committee for Aeronautics pilot Scott Crossfield became the first person to fly faster than twice the speed of sound when he piloted the D-558-2 to its maximum speed of 1,291 mph on 20 November 1953. Its peak altitude, 83,235 feet, a record in its day, was reached on 21 August 1953, with Lieutenant Carl behind the controls.

J. D. Hunley

See also

Research Aircraft

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Douglas SBD Dauntless

U.S. carrier-borne dive-bomber; responsible for many of the early losses suffered by the Imperial Japanese Navy in the Pacific War. Variations of the SBD (for "Scout Bomber, Douglas") were used by the U.S. Army Air Forces, Royal New Zealand Air Force, British Fleet Air Arm, and the French navy and air force, but it was most successful with the U.S. Navy and Marine Corps.

The SBD Dauntless went through six major versions before production ended in 1944. Perforated dive flaps characterized all versions. Despite its primary role as a dive-bomber, the Dauntless had good air-to-air combat characteristics and was credited with 40 of 91 enemy aircraft shot down during the Battle of the Coral Sea. Its rugged design gave it the lowest attrition rate of any U.S. carrier-based aircraft in the Pacific War.

In 1942, Dauntlesses crippled Japanese striking power, sinking four fleet carriers at Midway. Beginning in mid-1943, they were phased out in favor of the Curtiss "Helldiver." Dauntlesses flew off escort carriers in antisubmarine and close air support roles for the rest of the war.

Grant Weller

See also

Antisubmarine Warfare; Close Air Support; Coral Sea, Battle of the; Douglas Aircraft; Midway, Battle of

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Douglas World Cruiser

By achieving the first aerial circumnavigation of the world on 6 April 1924, the Douglas World Cruiser set an aviation milestone. The press called it the greatest achievement in aviation history. Douglas aircraft thus became the first to fly the future routes of the global network of air commerce.

The Douglas World Cruiser was a conventional-looking biplane with a 50-foot wingspan and was powered by a 420-hp Liberty engine. Top speed was 103 mph and maximum range was 2,200 miles.

The four-plane flight of the *Seattle, Chicago, Boston,* and *New Orleans* ran into the worst weather of the century along the route. Rain, sleet, snow, and strong headwinds plagued the pilots. Clever logistics and good planning enabled them to overcome the hazards.

The flight took 175 days and covered 27,553 miles. The actual flying time was 15 days, 11 hours, and 7 minutes, averaging 74.2 mph. The *Seattle* went down off Alaska, and the *Boston* went down off the coast of Iceland, but each crew

The Douglas World Cruiser was a simple, sturdy design that had the stamina to undertake the first successful flight around the world. (U.S. Air Force)

survived. The two remaining World Cruisers flew over 28 countries and were the first to cross the Pacific Ocean. A fifth plane, the prototype *Boston II,* joined up with the flight at Nova Scotia. The *Chicago* may be seen in the National Air and Space Museum, the *New Orleans* in the Museum of Flying in Santa Monica, California.

Henry M. Holden

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Dowding, Hugh C. T. (1882–1970)

Air vice marshal and head of RAF Fighter Command during the Battle of Britain. "Stuffy" Dowding is credited with much of the planning and leadership that staved off defeat in 1940 from the German Luftwaffe.

He entered the British army in the late nineteenth century, transferring to the new RAF upon its formation in 1918, having paid for his own flight training. He was knighted in 1935 for his important work in aircraft procurement. A year later, he became head of the new Fighter Command and strongly encouraged the development and use of radar as a key part of the defense of Britain.

Along with the Ground Observer Corps, complex command and control facilities, the new Hurricane and Spitfire interceptors, and the welding of the whole into a highly trained and cohesive weapons system, Dowding's preparations created the successful edge over Germany in the 1940 Battle of Britain. But despite support from Air Vice Marshall Keith Park about the use of smaller groups of fighters meeting invading German aircraft as early as possible, Dowding lost out in the late-1940 policy debate to Air Vice Marshall Trafford Leigh-Mallory's support of "big wings" of defense aircraft; he was replaced in November 1940.

He headed an unsuccessful British mission to the United States seeking more aircraft and then retired in mid-1942. In recognition of his efforts for the RAF, Dowding was made a lord in 1943 (the first from the RAF since Hugh Trenchard).

Christopher H. Sterling

See also

Britain, Battle of; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Trenchard, Hugh

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Dresden, Bombing of (1945)

Controversial Allied combined bombing mission late in World War II that has become a symbol for the excesses of strategic bombing. Much of this reputation is based on Cold War distortions of the facts. Britain's RAF Bomber Command and the U.S. Eighth Air Force mounted coordinated attacks on the German city on 14 and 15 February 1945.

Contrary to popular beliefs, the city did contain valid military targets, and the mission was prompted by Russian requests for attacks on transportation centers like Dresden to assist their advance into Germany. But the raid was also related to Operation THUNDERCLAP, a British-inspired plan to break German morale from the air by destroying Berlin, and the large RAF formation succeeded in igniting a firestorm at night that degraded the accuracy of supporting USAAF daylight attacks. The bombing and its aftermath confirmed American misgivings about THUNDERCLAP.

According to official German records, 25,000–35,000 people died in the conflagration. This was the third deadliest bombing raid of the war in Europe, ranking behind only the 1943 Allied attack on Hamburg and the 1942 German assault on Stalingrad.

Reports of the destruction and a briefer's offhand remark that the Allies were adopting terror bombing caused a serious backlash, especially in Britain, and contributed to the end of strategic bombing in Europe. After the war, German and Russian propaganda propounded much higher casualty figures, which were reinforced by David Irving's influential book that settled on a death toll of 135,000. Irving later recanted and accepted the lower total from German records, but his earlier high claim is still widely cited.

Conrad C. Crane

See also

Berlin Air Battles; GOMMORRAH; Hamburg Bombing Campaign; Stalingrad, Battle of; Terror-Bombing

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Dunkirk

The Luftwaffe dominated the skies over France during the May 1940 blitzkrieg. Within days, the Royal Air Force stationed in France had lost half of its combat-ready bombers. Its Hurricane fighters fared no better. Fighter Command was quickly down to 39 squadrons, less than the required 60 for defense of Great Britain. The Germans were just across the English Channel, in Holland, threatening to overwhelm Belgium as well. By 20 May, the British were exploring options for evacuating from Calais to Dover. Then Adolf Hitler halted the ground effort. Still, the British Expeditionary Force at Dunkirk endured heavy air and artillery attacks as well as strafing by Messerschmitts, bombing by Dorniers and Heinkels, and dive-bombing by Stukas.

The assignment of Sir Hugh Dowding's RAF Fighter Command's was to patrol the beach for three miles on each side of Dunkirk from daylight to dark while continuing to protect the retreat and escort the British Fairey Battles and Bristol Blenheims. British forces also had home defense duties, so the 200 planes had as little as 20 minutes over Dunkirk before they withdrew. The German fleet included 300 bombers and 550 fighters. The outnumbered British routinely sent eight to 20 plane sorties against up to 50 of the enemy. At that point, the RAF pilots lacked experience, their communications were monitored, and they came in too low, giving the altitude advantage to the Germans, who gladly swooped down from the sun. Still, the RAF disrupted the attacks enough that the retreat and evacuation succeeded. At the end of the evacuation the RAF was outnumbered 8:1, but when Operation DYNAMO ended on 4 June, 364,628 Allied troops had been evacuated, and only 30,000–40,000 French had to surrender. Dunkirk cost 106 RAF fighters, 80 pilots, and 77 bombers. The fighter force was reduced to a total of 524 aircraft for the coming Battle of Britain.

John Barnhill

See also

Dowding, Hugh C.T.; German Air Force (Luftwaffe); Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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E

Eagle Squadrons

America was still at peace in 1940, but some American young men were very much at war. They were the transport pilots, cropdusters, washed-out cadets, students, and other adventurous youths who had gone to Canada and enlisted in the Royal Canadian Air Force. After basic training, they had been sent to England for operational training and assignment to Royal Canadian Air Force or Royal Air Force units.

In October 1940, these Americans transferred to the newly organized RAF No. 71 Squadron, the first of the Eagle Squadrons. They wore the RAF uniform with the distinguishing Eagle Squadron patch on the left shoulder. The No. 21 and No. 133 Squadrons were formed as more Americans signed up.

In September 1942, after the U.S. Army Air Forces began operations in England, the Eagle Squadrons were transferred to U.S. control. However, Squadron Leader J. C. Nelson of Denver, Colorado, one of the first Americans to fly for Britain and who fought in the Battle of Britain, elected to remain with the RAF. Flight Lieutenant Chesley Peterson of Utah and Flying Officer Gregory Daymond of California, both Eagle Squadron commanders, became aces in the Battle of Britain. Peterson later became known as the "21-year-old colonel."

After transferring to the USAAF, the three Eagle Squadrons were organized into the 4th Fighter Group stationed at Debden. They retained their Spitfires under a reverse Lend-Lease arrangement.

Albert Atkins

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Eaker, Ira C. (1896–1987)

American aviation pioneer and general. Born in Field Creek, Texas, on 3 April 1896, he enlisted in the Army in 1917 following graduation from school and was accepted to officer training and commissioned as an infantry officer. He did not serve overseas during World War I; instead he was sent to the Aviation Section of the U.S. Army Signal Corps, where he learned to fly and earned his pilot's wings in October 1918. Over the next several decades, he participated in some of the most daring and innovative flights of the time. In 1926, Captain Eaker was second in command of a 22,000-mile goodwill tour by Army planes that circled Central and South America. Three years later, he piloted the Army Air Corps's "Question Mark" flight, which established a world endurance record by remaining aloft more than 150 hours in a series of pioneering airborne refueling operations. Besides these monumental fights, Eaker's name ranks with such prominent air advocates such as William "Billy" Mitchell, Henry H. "Hap" Arnold, and Carl "Tooey" Spaatz in the fight for the enhancement of airpower as the most important strategic arm of the military.

Eaker progressed through the ranks until earning two-star status as a major general just prior to World War II. It was in this war that he established his reputation as an airman. He commanded the famed Eighth Air Force in Britain in 1942 and 1943, then went on to command the Allied air forces in the Mediterranean in 1944 and 1945. During the last months of the war, he became deputy commander of the Army Air Forces and chief of the Air Staff in Washington, D.C.

During the war, General Eaker personally led the first U.S. B-17 bomber strike against German occupation forces in France (against Rouen on 17 August 1942). As commander of the Fifteenth Air Force in the Mediterranean, he flew the first bombing raid from Italy into Germany, landing in the Soviet Union after striking a series of military targets. He advocated precision daylight bombing, a tactic that most Allied leaders were skeptical about. In addition, he also developed the plan to bomb enemy targets around the clock using U.S. B-17s to strike by day and Royal Air Force bombers to attack by night.

Before he retired from Air Force service in June 1947, General Eaker worked closely with General Spaatz and Assistant Secretary of War W. Stuart Symington to establish a separate U.S. Air Force. Awards would follow. He received the Silver Star, the Distinguished Flying Cross, and myriad other military awards from other countries as well as the United States, including a special Gold Medal from Congress in 1979.

After his Air Force retirement, General Eaker worked at the Hughes Tool Company and Hughes Aircraft until 1957. For almost two decades, he wrote a column on military affairs that was syndicated to 180 newspapers. He died in 1987, two years after President Ronald Reagan awarded him his fourth star. The wartime hero and aviation pioneer is buried at Arlington National Cemetery.

George M. Watson Jr.

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Ira Eaker and Carl Spaatz were two brilliant officers whose careers intertwined, from before the famous flight of the Question Mark *in 1929 to the sending of the Eighth Air Force against Germany. Here Spaatz is pinning another well-earned decoration on Eaker. (U.S. Air Force)*

Eastern Solomons, Battle of the (1942)

Carrier engagement during the Guadalcanal Campaign in August 1942. A Japanese fleet under Admiral Nobutake Kondo (carriers *Ryujo, Shokaku,* and *Zuikaku*) moved south from Truk to cover resupply and reinforcement operations to Guadalcanal. The fleet was spotted by reconnaissance, and a U.S. force under Admiral Jack Fletcher steamed to intercept (carriers *Enterprise* and *Saratoga,* with *Wasp* refueling to the south).

The Americans struck first, at a force acting as bait, and sank *Ryujo* with a 38-plane strike. Shortly after that force was launched, reconnaissance discovered the main Japanese carrier force, but poor radio communications, due in part to weather conditions, made it impossible to divert the strike force to the more attractive target.

The Japanese strike force scored three bomb hits on *Enterprise,* but successful damage control allowed the ship to continue to operate aircraft. A follow-up U.S. strike sunk the seaplane tender *Chitose;* a subsequent Japanese strike was unsuccessful in locating the U.S. fleet. Both sides then retired. Although usually considered an American victory for the sinking of *Ryujo,* Japanese resupply of Guadalcanal was successful.

The Battle of the Eastern Solomons showed the importance of communications with air units in flight to allow reaction to changing situations. It also illustrates the importance of effective damage control in allowing a carrier to maintain flight operations. This was an area where the Japanese were initially deficient, and became progressively more so, while the Americans entered the war with a high degree of proficiency that was steadily improved.

Frank E. Watson

See also

Guadalcanal

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Ebro 33: Rescue Efforts

Demonstration of NATO efforts to rescue downed aircrew members. On 30 August 1995, a French Mirage 2000K aircraft, call sign Ebro 33, was shot down by Serbian forces as it was attacking an arms storage area 20 miles southeast of Pale, Bosnia-Herzegovina. This mission was part of NATO Operation DELIBERATE FORCE.

The Mirage was hit by a Serbian surface-to-air missile. The missile severely crippled the aircraft, and the crew of Captain Frederic Chiffot and Lieutenant Jose Souvignet ejected. The two pilots were immediately captured by an armed civilian and passed to Serbian army forces. But NATO commanders were unaware of this and began immediate planning for rescue operations.

Early on the morning of 6 September, Admiral Leighton Smith, commander of NATO's southern forces, ordered the USS *Roosevelt* to execute a search-and-rescue mission. It launched a task force consisting of HH-60 helicopters from Helicopter Squadron 3 (HS-3) and U.S. Navy SEALs from Delta Platoon, SEAL Team-8, onboard for just such emergencies. But bad weather in the recovery area prevented the force from searching for the two Frenchmen.

Admiral Smith determined that the collected intelligence warranted another attempt. This time, he tasked the mission to the Joint Special Operations Task Force (JSOTF) at Brindisi, Italy. Early on the morning of 7 September, it launched a package consisting of two MH-53 "Pave Low" helicopters, AC-130 gunships, A-10s, and other supporting aircraft. Onboard the two helicopters were both U.S. and French personnel trained to search for and recover the missing airmen. But once again, the horrible Bosnian weather precluded a comprehensive search of the area. Admiral Smith ordered the JSOTF to launch a third attempt on the evening of 7 September. This time the weather was perfect for the mission. AC-130 aircraft entered the area and began the search. Two more MH-53s launched as the recovery aircraft.

The search was fruitless. But it did catch the attention of Bosnian Serb forces in the area. An estimated eight antiaircraft guns of varying sizes began firing at them. Both the AC-130 and helicopters returned fire. Additionally, supporting A-10s and F-18s attacked the enemy guns. As the helicopters turned to depart the area, both were hit numerous times. Onboard, two sergeants, Randy Rutledge and Dennis Turner, were wounded, although neither seriously.

Reviewing the negative results of the three efforts, Admiral Smith decided against any further missions. Subsequently, it was revealed that some of the signals received and objects observed by the rescue forces had been fakes purposely created by the Bosnia Serb forces. In October, the French government determined through other sources that the two men had been captured by the Bosnians and were being held in an undisclosed location. They were eventually released to French authorities as an initial step in the Paris Peace Agreement and the Dayton Accords, which ended the conflict.

The rescue attempts for the crew of Ebro 33 had been unsuccessful. But the level of effort sent a powerful message to all of the NATO aircrews. They knew that if they were shot down, they could count on the rescue crews to try to get them. It bonded together the men from the various allied nations into one unified force.

Darrel Whitcomb

Egyptian Air Force

The roots of Egypt's air forces run back to 1912, when an improvised Egyptian antiaircraft battery brought down an Italian Nieuport. During World War I, the Egyptian army engaged in some operations in cooperation with the Royal Flying Corps.

The direct antecedent of the current Egyptian Air Force was established in 1932, as a political gesture on the part of the British who still dominated Egypt, nominally an independent kingdom. The first Egyptian airmen were trained by the Royal Air Force and operated RAF aircraft. When World War II began, the Royal Egyptian Air Force (REAF) operated a single fighter squadron, flying Gloster Gladiator biplane fighters.

The REAF was beset by internal problems, including subversive action by a number of officers, one of whom was Anwar Sadat, later president of Egypt. The REAF was essentially grounded because of this and did not emerge as a fighting force until after the Axis powers had been driven from Africa.

After World War II, the REAF was given more autonomy and equipped with modern aircraft, including Supermarine Spitfires. By 1947, it included three fighter squadrons, as well as a mixed bag of transport and liaison aircraft. These were used in the series of battles that culminated in the Israeli War of Independence in 1948–1949.

When in 1952 Egypt rebelled against British influence and established itself as a sovereign state, it created the Egyptian Air Force, with six squadrons of fighters, including three equipped with Gloster Meteor and de Havilland Vampire jets. It turned to the Soviet bloc for more modern arms and eventually received MiG-15 fighters. By 1967 it had grown greatly in strength and had several hundred MiG fighters, including MiG-15s, -17s, and -21s as well as about 65 bombers, including Ilyushin Il-28s and Tupolev Tu-16s.

Israel destroyed this formidable force in the Six Day War of October 1967. Egypt rebuilt its air forces during the so-called War of Attrition and the October War of 1973 but was never able to achieve the training and level of proficiency of its opponent, the air arm of the Israeli Defense Force.

After 1973, Egypt developed a larger and more diverse air force, operating aircraft from the Soviet Union, the United States, France, and China. Emphasis is now being placed on the acquisition of Lockheed Martin F-16s. Egypt's Air Defense Command is a separate organization, responsible for operation of surface-to-air missiles and antiaircraft weapons. The Air Defense Command was notably successful during the 1973 October War. The expansion of Egypt's air forces may be due in part to the fact that Egypt's president, Hosni Mubarak, was formerly commander in chief.

Walter J. Boyne

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Ejection Seats

Rapid egress from stricken aircraft. Ejection seats came into common use soon after World War II, with the increased dangers of inflight evacuation from high-performance jet aircraft.

Early designs for ejection seats date back to 1910, but significant progress was not made until the 1930s. The first successful ejection occurred in 1934, when a German pilot inadvertently triggered the spring-loaded ejection seat of his Dornier 23 monoplane. The first deliberate ejection seat escape was also made by a German pilot in 1943. By the end of World War II, German airmen had employed ejection seats more than 60 times.

Early seats were purely ballistic, being activated by springs, compressed air, or an explosive device. Unfortunately, the extreme acceleration forces they created often resulted in pilot injury. To lessen these forces, as well as achieve zero-zero seat capability—the ability to eject while sitting motionless on the ground—rocket sustainers were added. These softened the shock of ejection and propelled pilots to sufficient altitude for safe parachute deployment. Other features, such as automatic parachute deployment, computer-controlled ejection functions, and vectored, variable thrust rockets, have further increased ejection survivability.

To date, ejection seats have been used more than 12,000 times and are standard equipment in high-performance military aircraft.

Steven A. Ruffin

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El Alamein, Air Battles of (1942)

Crucial element of the successful British breakthrough in the Western Desert. The British Eighth Army's effort to prevent an Italo-German descent on Alexandria and Suez culminated successfully at El Alamein (24 October–4 November 1942).

At the battle's outset, Axis forces fielded some 675 aircraft. The Luftwaffe's contribution was 275, Italy's Regia Aeronautica 400. Of these, approximately 350 were serviceable. Royal Air Force and attached U.S. Army Air Forces aircraft numbered 750, including some 530 serviceable machines. They comprised an Anglo-American Desert Air Task Force (DATF) under U.S. command. The DATF's fighters and light bombers would be used against Italo-German forces in the battle itself while RAF and U.S. Army Middle East Air Force heavy bombers struck lines of communication and reinforcement stretching back to Tobruk, Benghazi, and Tripoli. Additionally, aircraft based on Malta and the Royal Navy's carriers successfully continued their interdiction of Axis maritime reinforcement.

From the opening barrage, preceded by a wave of 125 medium bombers blasting German and Italian artillery batteries, Allied airpower dominated the skies. Of particular note was the USAAF's 57th Fighter Group's aerial victory on 27 October. Sixteen of the Group's Curtiss P-40 "Warhawks" decisively scattered—with no loss to themselves—a force of some 60 German and Italian fighters and dive-bombers, downing seven in the process. All the while, 12th Medium Bombardment Group's North American B-25 "Mitchells" and RAF Douglas DB-7 "Bostons" savaged Axis armored formations, infantry positions, and assembly areas. These constant attacks helped disrupt Axis counterattacks and forced German Field Marshal Erwin Rommel to initiate a withdrawal on 3–4 November. The British advance to Tunisia had begun.

D. R. Dorondo

See also

North African Campaign

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EL DORADO CANYON (1986)

Code name for attack by United States Navy and Air Force aircraft on targets in Libya during the night of 14–15 August

1986. The operation was a response to Libyan support for terrorist activities, especially the bombing of a Berlin discotheque that was frequented by U.S. servicemen. The raid was preceded in March 1986 by skirmishes between the U.S. Navy and the Libyan military over the international status of the Gulf of Sidra and Libyan leader Muammar Qaddafi's declared "Line of Death."

The Sixth Fleet, including the aircraft carriers USS *America* and USS *Coral Sea,* and the 48th Tactical Fighter Wing (48th TFW) stationed at RAF Lakenheath in the United Kingdom, performed the mission against five military and terrorist training targets. Eighteen General Dynamics F-111Fs from the 48th TFW hit three targets in the Tripoli area, and 14 Grumman A-6Es from the two carriers struck the two targets near Benghazi. The attack aircraft were supported by EA-6Bs and EF-111As for radar-jamming, Vought A-7Es and McDonnell Douglas F/A-18Cs for defense suppression, and Grumman F-14s to counter any Libyan fighter response. Navy Grumman E-2Cs provided AWACS support during the raid. The F/EF-111s were also supported by Boeing KC-135 and McDonnell Douglas KC-10 tankers that provided multiple aerial refuelings in their 13-hour, 5,500-nautical-mile round-trip. One F-111F and its two crewmen were lost to enemy action during the raid. Although not all aircraft successfully hit the assigned targets, EL DORADO CANYON inflicted substantial damage. The raid was considered a success based on the clear demonstration of U.S. willingness to respond to state-sponsored terrorism and the apparent effect of reducing aggressive Libyan support for terrorist actions. The Navy considered the raid to be a clear demonstration of the ability to project power from the sea, and the Air Force viewed the raid as an example of the ability to project power using aircraft from long ranges.

Jerome V. Martin

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Electronic Warfare (EW)

Includes electronic countermeasures (ECM) and electronic reconnaissance/intelligence (ER, or ELINT). ECM includes jamming to disrupt radar, communications, and other systems, both in missiles and in satellites. An enemy may counterjam with electronic counter-countermeasures (ECCM). During the Vietnam War, the U.S. Air Force used the term *electronic support measures* to describe the collection of signal data to ease jamming of North Vietnamese air defenses. The term *electronic reconnaissance* covers all forms of electronic data-gathering, whether or not it is used for jamming purposes.

ER provides a battlefield advantage. If accurate and timely, it allows the attacker the use of jammer aircraft or other means to blind the enemy's electronic eyes. A stronger transmitter can blank out the enemy's radarscope. Spot-jamming blocks a single frequency, whereas barrage-jamming blocks an entire band. A jammer aircraft that does not accompany the attackers to the target can still use powerful equipment from outside the battle area (standoff jamming). Chaff (small metal fibers dropped from an airplane) is also good for jamming, causing enemy radar to read aircraft-sized returns. Chaff also blinds radar, dropping slowly to provide hours of deception. Use of a signal generator to make the enemy radar show a false target is called "deception jamming." This process requires the perpetrator to know in great detail the enemy's frequencies.

ECM never gives unequivocal superiority. The enemy always has the capability of applying electronic counter-countermeasures. ECCM generates new ECM methods, active or passive, which in turn generate new ECCM in an ongoing technological seesaw.

Electronic warfare, especially signal intercepts, was first used in the 1904 Russo-Japanese War. Russian failure to jam Japanese radio was one factor in the Russian defeat at Tsushima. In World War I, because radios were too heavy for airplanes, EW consisted of direction-finding, jamming, and intelligence analysis of ground forces' radio, telephone, and Morse transmissions, whether encoded or clear signal.

Between the world wars, radar developed rapidly, with Germany having the edge. Germany also had the edge in radar detection. Britain managed to trap the *Graf Spee* in 1939 and sink the *Bismarck* in 1941 despite the Germans' apparent edge. Britain had accelerated its own radar and radio intercept development, gaining EW superiority in the 1940 Battle of Britain.

By World War II, radios were lighter, planes were stronger, and radar was available to detect and track aircraft. ELINT collection requires sensitive receivers, direction-finding equipment, and sophisticated equipment to measure the operating characteristics of electronic systems. Specially equipped B-17 and B-24 bombers traced enemy signals and, tuned to the right frequencies, jammed enemy radar and electronics during bombing missions.

With postwar reduction of military spending, by 1950 the United States had ER but no jamming capability. The Air

Force used ER to map electronic radar sites so its planes could get through radar-controlled guns and searchlights; fighters had to rely on speed, maneuverability, and the cover of night. After the Korean War, ECMs developed as the enemy introduced new types of radar and communications systems.

By the late 1950s, modern air defense systems used complex command and control communications to link weapons, radar, and command posts. ER flights continued to track and identify enemy resources. This information was needed to steer attacking friendly aircraft away from enemy missile sites and radar. It also supported intelligence. Failures, such as the capture of Francis Gary Powers in 1960 with his 1950s-vintage U-2, and the ERB-47 shot down the same year, demonstrated that electronic intelligence–gathering missions were not risk-free.

In Vietnam, the Air Force used a mix of ECM and surface-to-air missile suppression aircraft to protect the B-52s during LINEBACKER I and II. Up to 85 aircraft supported each nightly bomber raid. Chaff dropped by F-4s and EB-66s blinded North Vietnamese early warning and acquisition raiders. Jamming EB-66s and EA-6Bs blocked North Vietnamese ground-controlled intercept radar. The North Vietnamese countered with band-switching, frequency changes, and quickly shutting off radar to hide its location and to cut down the time EB-66s had to learn the radar's capabilities.

For a time, the U.S. Air Force believed that pod jammers, carried by the fighters themselves, would provide adequate protection. Sufficient during the Vietnam War, pod protection failed during the 1973 Arab-Israeli War. Pods failed to jam the SA-6 Gainful SAMs. Israeli Air Force pilots had to fly below radar, opening themselves to antiaircraft (AA) fire.

During the Vietnam War, the U.S. Air Force developed the Wild Weasels, a series of fighters modified to find the electronic emissions of SAM and AA raiders and attack the sites (suppression of enemy air defenses, or SEAD). When the military focus shifted back to the Central Front in West Germany after the Vietnam War, it faced a Soviet integrated air defense system of such magnitude that, for SEAD to work, a part of the radar network would have to be jammed. First, the Air Force had to map the Soviet capability. Similar problems existed in Korea. Times called for an ELINT collector.

The Air Force conceived the tactical electronic reconnaissance sensor (TEREC)–equipped RF-4 in 1970, but the sensor system did not arrive in United States Air Force Europe (USAFE) and the Pacific Air Forces (PACAF) until 1975. The ALQ-125 pod determined precisely the enemy's electronic order of battle. It had automatic detection, classification, and location of hostile ground-based emitters and was preprogrammed to seek out systems defined as the highest threat. It tracked quickly, then sent data real-time to ground-based intelligence facilities.

Once a radar had been identified, tracking continued just long enough to permit its precise location to be determined. A real-time data link sent relevant information to ground-based intelligence facilities. Twenty-four TEREC pods were deployed to USAFE and PACAF on RF-4Cs. They were not replaced as the RF-4Cs retired. Another tool, the U-2R (TR-1) precision location strike system, operated briefly in Europe before the collapse of the Soviet Union. This tool had passive detection capabilities and real-time data links.

The Vietnam-era EB-66s tried to jam communications between radar sites and SAM launchers and between MiGs and their ground controllers.

The 1973 Arab-Israeli War produced a new Air Force system, the EC-130H "Compass Call," that performed basically the same missions. Compass Call used C-130s carrying complex computers and electronics. Input to Compass Call came from antennas placed on the plane's fuselage in front of the wings. An antenna array behind the wings transmits powerful jamming signals. The aircraft also uses its on-board computers to prevent enemy jamming of its signals or friendly frequencies. The EC-130H crew of specialists adjust jamming parameters in flight. This is "person-in-the-loop" versatility.

The EC-130H breaks complex and interdependent enemy systems into smaller pieces, then destroys or disrupts them by spot-jamming of selected frequencies, not broad-band barrage-jamming. Its on-board crew can assess and improve its operations on the fly. The EC-130H is the best jammer in the sky.

Stealth, the Air Force believed, was a better way to get an aircraft to its target. Instead of jamming and thereby alerting the enemy, stealth would allow the aircraft to sneak in. Slowly, in the 1990s, the EW planes went away. The F-4G Wild Weasel retired in 1992 and was replaced by the F-16CJ with the HARM targeting system. The EF-111 saw action in Libya in 1986, DESERT STORM in 1991, and the Southern and Northern no-fly zones over Iraq until 1998. Then the final dozen EF-111s retired. The Air Force and Navy then pooled their EW in the EA-6B Prowler.

Operations after Iraq and Yugoslavia demonstrated that Third World countries using air defense weapons similar to those used in Vietnam from 1965 to 1973 could still down U.S. aircraft or hamper air operations. While the EB-66s were flying over Vietnam, the Navy had begun working on carrier-based jammers—the piston-engine EA-1F, then the EKA-3 (an enhanced A-3D, the predecessor of the USAF EB-66). Wanting just one type of aircraft, the Navy looked into an EW A-6. The first variant was the two-seat EA-6A flown by the U.S. Marine Corps from Da Nang. The Navy wanted more capability. An elongated A-6 accommodated two additional electronic warfare officers . This version, the EA-6B Prowler, flew combat missions over North Vietnam in 1972. The aircraft received continuous updates to its electronic equipment. When the EF-111s were phased out of service in 1998, four new "purple" (joint) USN/USAF-manned Prowler squadrons picked up the Air Force electronic warfare mission.

Contemporary EW includes threats to satellites. Computer hackers can penetrate communications networks that guide satellites and receive their data. Hiding or disguising targets is easy once satellite orbital and sensor characteristics are known. Jamming devices can be as small as a cigarette pack. Ground lasers can blind sensors and cameras. And microsatellites or nanosatellites can spy on other satellites or, if armed, damage or destroy them. Countermeasures include antisatellite missiles fired from F-15s, hardening and stealth technology, antijamming, and antilaser deflector. Yet human intervention—sabotage of ground-based stations—remains a viable counter to EW.

John Barnhill

See also

Defense Suppression; DESERT STORM; Wild Weasel

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Ellyson, Theodore Gordon (1885–1928)

American aviation pioneer. Theodore Gordon "Spuds" Ellyson was born on 27 February 1885 in Richmond, Virginia. After graduating from the Naval Academy in 1905, he was assigned to the battleship *Texas.* Serving for several years aboard various battleships and cruisers, Ellyson was assigned to the submarine *Shark* in 1908. On 23 December 1910, his request for duty in connection with aeronautics was accepted. He was ordered to the Glenn Curtiss Company training field at Dominguez Field, south of Los Angeles. On 2 July 1912, Ellyson took and passed his aero test and became Aero Club License No. 28, Military Aviator No. 26, and Naval Aviator No. 1.

On 7 September 1911, the first naval aviation unit was organized, with Lieutenant Ellyson as its commanding officer. For the next 18 months, Ellyson trained naval aviation volunteers and conducted various experiments associated with aircraft. However, at this time promotion within the Navy depended upon time spent at sea. Therefore, on 29 April 1913 he was detached from aviation and assigned to the USS *South Carolina.* In January 1918, Ellyson was transferred to subchasing duty. Following the war, Ellyson transferred to destroyer duty. In January 1921, Commander Ellyson returned to aviation, and he became executive officer of the Hampton Roads Naval Air Station. Ten months later he joined the Navy's Bureau of Aeronautics in Washington, D.C.

Wishing to get back to sea in an aviation role, Ellyson got himself appointed commanding officer of Squadron VT-1 in July 1922. In September 1928, Ellyson reported to the inspector of machinery at Boston for duty aboard the USS *Lexington.* On 25 February 1928, Ellyson learned that his daughter had a serious infection. He received permission to fly home in a Loening OL-7 amphibian from Hampton Roads to Annapolis. The aircraft crashed at the mouth of Chesapeake Bay, and Ellyson was killed.

Noel C. Shirley

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Ely, Eugene (1886–1911)

Early U.S. pilot. Eugene Ely was raised on an Iowa farm, graduated from Iowa State University, and became a chauffeur and one of the first race-car drivers. In 1909, he moved to San Francisco to sell cars. He married and relocated to Portland, Oregon, where he taught himself to fly. Then he moved to Minneapolis, joined Glenn Curtiss's fledgling aircraft company, and received pilot's license no. 17.

On 14 November 1910, Ely took off in a 50-hp Curtiss plane from a specially constructed wooden platform built over the bow of the light cruiser USS *Birmingham,* anchored in Hampton Roads, Virginia. A few minutes later he landed on Willoughby Spit. On 18 January 1911, at 11:01 A.M., Ely landed a Curtiss pusher on a specially built platform on the armored cruiser USS *Pennsylvania* anchored in San Francisco Bay. Ely was so cold from his hour-long effort that he was literally blue, but Navy coffee brought his color back. Ely's landing and takeoff marked the birth of naval aviation.

After his landmark feats, Ely continued exhibition flying. At the Georgia State Fairgrounds in Macon on 11 October, Ely's plane crashed. Thrown from his seat, he died of a broken neck. The crowd stripped souvenirs from the plane and clothing from Ely's body.

John Barnhill

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ENDURING FREEDOM

Operation ENDURING FREEDOM is the name for the U.S. military response to the 11 September 2001 terrorist attacks. That morning, Al Qaeda–backed terrorists hijacked four U.S. commercial airliners. Two of the planes were slammed into the twin towers of the World Trade Center in New York City, a third hit the Pentagon outside Washington, DC, and the fourth crashed in the Pennsylvania countryside near Pittsburgh when the passengers attacked their hijackers, sacrificing themselves in the process. The total loss of life from the day's tragedies has not been established but is expected to exceed 3,000.

The immediate reaction of the U.S. government was to suspend all air traffic within the United States and establish combat air patrols (CAP) over several major U.S. cites. President George W. Bush, declaring the attacks "an act of war," announced the commitment of the full resources of the United States against the terrorists and the elimination of any distinction between the terrorists and those who harbor them.

The United States quickly began establishing an international coalition, at the same time mustering U.S. forces to attack the Al Qaeda terrorist organization to which the Taliban government gave a safe haven in Afghanistan. The obstacles to a successful campaign were formidable, for the United States possessed no military bases near Afghanistan, and the deplorable condition of the Afghan economy ruled out a bombing campaign similar to those used on Iraq in 1991 and Serbia in 1999. At the same time, many political and military commentators warned about involvement in an Afghan war, citing the debacle of the Soviet Union's invasion of the country in 1979. Despite the lean years of the Clinton administration, which had seen military budgets reduced time and again, the armed forces of the United States nonetheless had at the ready a whole generation of new weapons to be employed with entirely new tactics. The responsibility for utilizing these forces fell to the commander of U.S. Central Command, Army General Tommy Franks, who planned Operation ENDURING FREEDOM. The objective of the operation was simple: carry out the president's promise to destroy Al Qaeda in Afghanistan and elsewhere.

The United States opened the bombing campaign in early October with Northrop Grumman B-2s staging from Whiteman AFB, Missouri. The 44-hour missions flown by the B-2s were the longest combat sorties in the history of air power. Joining the CONUS-based bomber in the opening phase of the campaign were Boeing B-52 and B-1B bombers staging from Diego Garcia in the Indian Ocean as well as a sizable naval contingent. The Navy's F/A-18s and F-14s were called on to fulfill the primary fighter bomber role. Additionally, the Navy utilized the ship-launched Tomahawk land attack missile (TLAM) to strike targets that posed a potential threat to manned aircraft.

The United States pitted high-technology weaponry against an enemy that use obsolete weapons but took advantage of the exceptionally rough terrain. The vast majority of munitions dropped were precision-guided. These included laser-guided munitions such as the GBU-10 (2,000 pounds), GBU-12 (500 pounds), and GBU-24 (2,000 pounds), electrooptically guided munitions such as the GBU-15 (2,000 pounds) and AGM-130 (2,000 pounds), and GPS-guided weapons such as the GBU-31 (2,000 pounds). The GPS-guided joint direct attack munition (JDAM) became the weapon of choice for the entire bomber fleet.

In addition to advanced munitions, the United States also made extensive use of unmanned aerial vehicles (UAV). Both the Predator and the next-generation UAV, the Global Hawk, were used as reconnaissance platforms to provide real-time video to the intelligence community. The Predator made history when it employed the Hellfire missile in combat, thus becoming the first unmanned strike aircraft.

The United States also introduced a limited number of Special Forces personnel, who scouted targets and identified them for precision bombing. Special Forces aircraft played a role when the venerable AC-130 gunship was called in to pound Al Qaeda positions with its 25mm, 40mm, and 105mm cannons. Additionally, MC-130s dropped the 15,000-pound BLU-82, which was originally designed as an area weapon to clear a hilltop for a firebase.

The final effects of Operation ENDURING FREEDOM are not yet known, but the initial result was the establishment of a provisional Afghan government that will undertake to establish order and prepare the country for a transition to a democratically elected government. In the meantime, selective anti–Al Qaeda operations continue in an effort to destroy any of the organization's leadership remaining in the country.

Walter J. Boyne and Troy D. Hammon

Energy Maneuverability

Concept used in air combat to compare the capability of opposing aircraft by assessing the ability of an aircraft to accelerate or climb at a given load factor (g). It is expressed as specific excess power (SEP—feet per second or meters per second) and defined as excess thrust multiplied by speed and then divided by weight.

The aim of air combat is to gain a position advantage over an opponent so that the fighter's weapons can be employed. Two basic approaches to air combat are available. First, a pilot can try to gain a position advantage at the expense of some energy ("angles" tactics) with the intent of further improving his advantage until he has a firing solution. For example, a maximum-rate turn toward an opponent's rear quarter will gain an immediate position advantage but may sacrifice some speed and altitude. Alternatively, a pilot can attempt to gain an energy advantage over his opponent at the expense of some position ("energy" tactics), with a view toward converting the energy advantage to a decisive position advantage. For example, a vertical zoom will favor an aircraft with higher energy, as it will be able to delay pitching back downward until after the opposing aircraft.

Both these approaches require the fighter to expend some energy. The fighter that has a significantly higher SEP or higher initial speed or height will have the advantage.

The pilot of a lower wing-loaded aircraft (e.g., MiG-17) will tend to favor angles tactics because the turn rate will be higher. A fighter with higher thrust-to-weight ratio (e.g., F-4) will to climb and accelerate better and will tend to favor energy tactics. Angles tactics are inherently more aggressive and instinctive; energy tactics are generally safer but require a higher degree of pilot training.

Andy Blackburn

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Engine Technology

Although many early aircraft engines derived from the automotive experience, the rigorous demands of flying meant that an entirely new industry had to be created, one devoted to building engines of relatively high power and low weight and of maximum reliability. The development and manufacture of aircraft engines proved to be expensive and time-consuming; only those companies with demonstrated records of success could survive over the long term.

Although engine designs were proprietary, much of the technology of the industry quickly became generally available, so that most nations were able to build competitive aircraft engines for most of the century. Many of the technologies that go into the design and manufacture of aircraft engines are frequently developed by suppliers to the engine companies rather than by the primary engine manufacturer. As engines became more sophisticated, the number of types of engines and the number of manufacturers declined, and many companies were forced either to merge together or to enter into cooperative partnerships.

The goals of improving power and weight were usually the factors that drove the development process, with improvement in weight, size, and specific fuel consumption being beneficial side effects. Reciprocating engines and turbine engines each followed their own development paths, and each had specific challenges that had to be overcome. The pace of reciprocating engine development lagged behind that of airframe development for many years. After a slow start, jet-engine development proceeded at a much swifter pace, so much so that engine development led airframe development.

Just as reciprocating engines began to reach their practical peak of power in terms of weight and mechanical complexity, the jet engine arrived on the scene. Although the early jet engines generated a level of power roughly equivalent to reciprocating engines of the time, it was soon evident that they were capable of reaching far higher levels of power.

Beyond the benefit of ever greater power, the difference between the reciprocal motion of piston engines and the rotary motion of turbine engines carried important implications for maintenance that were not initially obvious. In the very earliest days, piston engines were far more reliable and could be run safely for many more hours than a jet. However, in a very short time the jet engine proved to be more reliable and to have greater endurance. Whereas piston engines required inspections and overhauls at frequent intervals, jet engines soon were able to run for thousands of hours with great reliability. And while the practicality of jet engines was initially doubted because of high fuel consumption, later jet engines were able to operate at high speeds and altitudes with remarkable fuel economy.

Reciprocating Engines

The development of the aircraft piston engine from the Manly Balzer liquid-cooled five-cylinder radial of 1903 to the Napier Nomad liquid-cooled O-12 of 1954 was the result of the development and interaction of the many technologies influencing engine design and operation. These included the following factors:

Materials: Higher-strength alloys led to lower weight, longer life, and greater power.
Fabrication techniques (casting, forging, machining, joining): Better processes led to longer life, lower cost, and greater strength.
Cylinder inlet and exhaust aerodynamics: Internal aerodynamic improvements led to greater volumetric efficiency (air-breathing capacity).
Cylinder cooling: Improved fin spacing, baffling, and cowling allowed more power per cylinder.
Valve cooling: Sodium-cooled valves allowed longer life and higher compression ratios.
Piston and ring design: Better materials and special shapes allowed longer life and higher compression ratios through better sealing.
High-power gearing: Better precision in manufacture, design of optimal tooth shapes, and better materials allowed higher engine speeds to match slow propeller speeds.
Journal bearings (material, configuration, fabrication, lubrication): The steel-backed bearing allowed higher engine speed and longer life.
Mechanical dynamics (balance and harmonics): The addition of crankshaft counterweights and bifilar dampers (harmonic counterweights) allowed higher engine speeds.
Vibration control (dynamics plus engine mounting): Strategic location of engine mountpoints and use of hydraulic mount pads reduced vibration input to the airframe.
Fuel formulation and production: Development of higher-octane fuels as well as different and improved means of formulating them was the biggest single contributor to improved engine power and efficiency.
Fuel metering: The addition of hydraulic computational mechanisms and altitude- and temperature-sensing features to carburetors/fuel controls allowed more precise matching of fuel delivery to the engine's needs.
Fuel combustion: Continuing studies of the combustion process lead to higher efficiency and reduced emissions.
Supercharging: Engine-driven compressors (mechanical supercharging) and exhaust-driven turbosuperchargers (turbochargers) allowed rated engine power to be maintained to high altitudes; aerodynamic analysis of the centrifugal compressor impeller, diffuser, and inlet/discharge ducting led to major improvements in efficiency and air breathing capacity.
Water-alcohol injection: Takeoff and emergency power was augmented by injection of large amounts of water and/or alcohol to cool the combustion chamber as well as to supercharge (by means of expansion of the water to steam) the engine.
Turbine compounding: The last step in evolution of the aircraft piston engine was the use of an exhaust-driven turbine geared to the engine crankshaft to extract greater power from the energy of the burned fuel.
Propeller aerodynamics: The improvement of propeller aerodynamic and mechanical design for a while allowed engines to operate at higher speeds without the need for reduction gearing.
Propeller mechanical design and control: The development of variable- and controllable-pitch propellers allowed the better matching of engine power and speed to the needs of the aircraft, leading to improved operating speed range, operating altitude, and overall propulsive efficiency.
Control and accessory size and effectiveness: Engine controls and accessories have become an increasingly significant fraction of the size, weight, and cost of the engine installation and have therefore become a very important driver of engine reliability.

Much of the time, these technologies were developed by companies other than engine manufacturers and became generally available to all manufacturers simultaneously. Sometimes the engine manufacturers had to force development of technologies when the normal suppliers refused to do so. Similarly, governments maintained engine development laboratories to investigate, guide, and evaluate technologies that the free market was not undertaking. Frequently, development was pointed in a needed direction by these government laboratories.

Sometimes, individual persons had an unusually large influence on the course of events—none more so than Samuel D. Heron, who had major roles in government laboratory development in Britain and then in the United States, as well as also in fuel development in the United States. Roy Fedden of Bristol Engines almost single-handedly developed the sleeve valve; Stanley Hooker of Rolls-Royce advanced engine aerodynamics tremendously; many others made major contributions.

Gas-Turbine Engines

The technologies supporting gas-turbine engines had a more important role in their development because the gas turbine would not even run until enough power could be generated

Aircraft engine developments took a great deal of time, and the superchargers that enabled the B-17s and B-24s to live over Germany derived from these early experiments with Sanford Moss's supercharger on a Liberty engine. (Walter J. Boyne)

in the combustor to drive a turbine that was efficient enough to drive a compressor efficient enough to not consume all of the turbine's power and have enough remaining to drive a propeller or develop thrust on the aircraft. Many early gas turbines fell short of their power goals because of these difficulties, in addition to the problems of containing (sealing) the high-pressure flows along the appropriate path. Thermodynamics dictates that efficiency is driven by the maximum temperature and pressure at the turbine entrance and the minimum temperature at maximum pressure at the compressor exit. The exposure of the combustor and turbine sections to continuous high temperatures demanded new materials that combined strength at temperature with resistance to oxidation and corrosion from impurities in the fuels. The component technology development situation for turbine engines was much the same as that for reciprocating engines except for the different perspective from there being many blades and vanes, higher rotating speeds, and higher average metal temperatures. One unique problem of turbine engines is that scaling down the size of the blades and vanes presents much more difficulty in the manufacture of the smaller and thinner parts. Sealing of leakages is also a problem, as the running clearances and boundary layers become a greater fraction of the total flowpath.

Following are examples of some of the major manufacturers of aircraft engines along with information on a few of their most famous products.

Allison

Allison began in Indianapolis as a rebuilder of used Liberty engines in 1924. Its most famous piston engine was the Allison V-1710, a monoblock V-12, which began development in

1930 as an airship power plant for the Navy, first giving 750 shp. Its development was retarded by the termination of the Navy airship program and by the Army's decision, during the Depression, that the lower system cost of air-cooled radials was most appealing. In 1935, the premonitions of war caused the pace of power development to increase, and the V-1710 was qualified at 1,000 shp in March 1937, ahead of the Rolls-Royce Merlin to that power but behind the Pratt and Whitney R-1830. Low-rate production started in 1938 for the Bell YFM "Airacuda" and prototype Lockheed P-38, Bell P-39, and Curtiss P-40 fighters. By 1940, the production rate was able to match the orders for these fighters.

Development of the V-1710 continued to improve durability and increase power to 1,325 shp for single-stage-supercharged engines, 1,500 shp for engines with a turbocharger as the second stage of supercharging, and up to 2,300 shp for engines with two mechanical superchargers and intercooling. The ultimate version had turbocompounding (exhaust turbine shaft driving into the crankshaft) in addition to a two-stage supercharger and demonstrated 2,800 shp in initial tests, with 3,000 shp expected after development; 70,033 V-1710s were built.

Allison produced thousands of the General Electric J33 and J35 jet engines by September 1946 and built more than 15,000 of its own T56 turboprop engines. It continued in the jet engine business and was particularly successful in supplying engines to the helicopter industry. More than 22,000 of its A-5 turboshaft model were supplied for the Bell Jetranger and the Hughes 500.

BMW

Founded in Germany in 1916, BMW (Bavarian Motor Works) came into prominence after 1929, when it licensed the Pratt and Whitney Hornet for production, modifying it with fuel injection. It became the basis for development of a long series of engines, which powered such famous aircraft as the Focke-Wulf Fw 190. BMW excelled in the close cowling of its engines, which reduced drag, and in the time required to change a complete engine package.

After the normal development problems, BMW created a turbojet engine that delivered 1,760 pounds/thrust. Intended primarily for the Heinkel He 162, about 3,500 had been built by the end of World War II.

Bristol

In July 1920, the Bristol Aeroplane Company was persuaded by the British Air Ministry to buy Cosmos Engineering (formerly Brazil Straker), which in mid-1917 had already started development of the Jupiter nine-cylinder single-row radial air-cooled engine at 1,753 cubic inches, with a goal of 500 shp at 650 pounds. Led by Roy Fedden, the new firm developed the Jupiter into a great success, for it came to be used on 262 different types of aircraft. More than 7,100 were built, and it was licensed in 17 foreign countries. It also inspired many descendants, including the Mercury and Pegasus, which were widely used in World War II aircraft.

The most distinctive Bristol engineering feature was the Burt-McCollum type of sleeve-valve engine, which was used on the Perseus, Hercules, and Taurus engines. The Hercules 14-cylinder two-row geared and supercharged radial engine was eventually developed to 2,080 shp at takeoff (2,140 shp emergency) at 2,355 pound-weight. The Short Stirling and Vickers Wellesley bombers were the first applications of the Hercules, which was used on many other aircraft of the era. The Taurus was a scaled-down Hercules that developed 1,050 shp at takeoff and was used on early Bristol Beaufort and Fairey Albacore aircraft.

The 18-cylinder two-row air-cooled Centaurus derived from the Perseus and was developed to 2,980 shp at takeoff. It was used to power the Hawker Tempest fighter and other aircraft. Some 5,330 Centaurus engines were produced through 1959.

In December 1940, Bristol began studies of turboprop engines and in July 1943 began development of the 1,975-shp Theseus free-turbine. In September 1944, design of the Proteus free-turbine turboprop began under Stanley G. Hooker. Some 400 flying Proteuses were built, but it achieved more importance when it was successfully applied to warship propulsion and electrical power generation.

In March 1947, Hooker began the design of a two-spool axial flow turbojet, the BE.10 Olympus. It first ran in May 1950, delivering 9,140 pounds/thrust but ultimately was developed to an astounding 38,400 rating with afterburner. At the other end of the power scale, Bristol developed the Orpheus for the Fiat G91 and Folland Gnat fighters, with an initial 3,285-pound thrust rating. It ultimately developed 8,170 pounds/thrust with afterburner.

One of the most innovative Bristol engines was the Pegasus, developed for the series of vertical-takeoff-and-landing fighters that culminated in the Harrier, achieving thrust of 23, 620 pounds. The company entered the helicopter field with the Gem, developed after it was absorbed by Rolls-Royce in October 1966 and used in the Westland Lynx and Augusta. Previously, the firm had joined Hawker-Siddeley to become Bristol-Siddeley in 1958.

Curtiss, Wright, and Curtiss-Wright

The early Curtiss aircraft engines came from motorcycle engines that founder Glenn Curtiss had designed. These were soon followed by an air-cooled V-8 in 1907. The OX-5 V-8, designed in 1910, developed 90 shp from 503 cubic inches and weighed 320 pounds. By World War I, it was suitable only as a trainer engine, but it was mass-produced for the Curtiss JN trainer and other aircraft until a larger engine became available. The K-12 was one of the first technologically superior American V-12s, with a water-cooled cast block and head (monoblock), producing 400 shp from 1,145 cubic inches and 679 pounds. The K-12 ran in October 1916 and had no significant production. For unknown reasons, Curtiss was not included in the Liberty engine planning of 1917.

The Curtiss 400-shp D-12 evolved in 1922 from the K-12, C-12, and CD-12 monoblock engines and revolutionized the engine industry in the early 1920s with its compactness, efficiency, and reliability. It was the dominant power source for U.S. fighters and smaller bombers in the 1920s and was succeeded by the Conqueror V-12 1,570-cubic-inch engine (initially 1,550) in 1926 at 575 shp. The Conqueror gained many military and some civil applications and was in production until 1932. It also influenced the design of the Rolls-Royce Merlin.

The aircraft engine industry in the United States began with the 16-shp Wright four-cylinder 201 cubic inches 152-pound-weight water-cooled inline for the Wright Flyer. Design was started in November 1902 and the engine ran in February 1903, flying in December. The Wrights sought help from auto-engine suppliers but, for lack of response, designed their engines with no known major outside influences. The Wrights developed the four-cylinder engine to 30 shp by 1911 and had a 50-shp six-cylinder by 1912 (this being uprated to 60 shp by 1914), but that line ended when the Wrights merged with Glenn Martin in 1915.

The Wright-Martin Company obtained rights to manufacture the 150-shp, 718-cubic-inch Hispano V-8 that year and spent several millions of dollars to design and tool for its manufacture. This engine, the Wright-Hispano, was one of the first examples of the monoblock design and was built in large quantities. For unknown reasons, Wright was not included in the 1917 Liberty engine planning. Wright-Martin was succeeded by the Wright Aeronautical Corporation in October 1919. On 26 June 1929, the two greatest names in American aviation, long antagonists, merged into the Curtiss-Wright Corporation.

Wright continued development of both the 718-cubic-inch and 1,127-cubic-inch V-8 Hispanos until 1923, when the Navy said it would not buy any more. In 1921, Wright started the T series V-12s of 1,947-cubic-inch displacement and 1,000 pounds. These began at 350 shp, ending with the T-4 of 675 shp in 1923, and competed with the D-12; 264 were built between 1921 and 1926 for many Navy aircraft, including two Schneider Trophy racers.

The U.S. Navy in the early 1920s, and the airlines in the late 1920s, announced a preference for air-cooled engines because of their lighter weight and greater reliability; the liquid cooling system accounted for 25–30 percent of engine failures. The first practical large air-cooled radial, the nine-cylinder Lawrance J-1, ran in 1921, and produced 200 shp from 787 cubic inches and 476 pounds. In 1925, this became the Wright J-5 Whirlwind of 220 shp that later powered the Ryan *Spirit of St. Louis* flown by Charles Lindbergh across the Atlantic. The Whirlwind was the engine of choice in its power range. Wright's engine of that era, the R-1, developed 350 shp from 1,454 cubic inches and was a failure; with redesigned cylinder heads and designated the R-2, it was satisfactorily demonstrated, but production was awarded to Curtiss. The Lawrance firm and Wright were then encouraged by the Navy to merge for the purpose of further developing and producing Lawrance designs.

In 1924, Wright had started work on the P-1/P-2, nine-cylinder, 1,654-cubic-inch supercharged radial, later designated the Cyclone, which was qualified in 1925 at 435 shp. This led to a long and successful series of Wright Aeronautical Corporation radial engines, including the R-2600 Cyclone 14, with cylinders from the R-1820 Cyclone 9, in late 1935. R-2600 power ranged from 1,500 shp at 1,950 pounds for the single-stage supercharged engine to 1,900 shp for the two-stage engines at about 150 pounds more weight. Next was the R-3350 Duplex Cyclone 18-cylinder radial, which began development in early 1936 with the same bore and stroke as the R-2600 with a goal of 2,000 shp and was qualified at 2,200 shp in March 1942, having been delayed by several development problems. Major problems were suffered in most of the R-3350's early applications, due partly to poor cylinder cooling and cylinder head design. Power had reached 2,750 shp by the end of World War II.

In 1946, Wright started the turbocompounding program for the R-3350, which was qualified in 1949 at 3,500 shp. In the jet field, Wright had its first and almost only major success with the J65, a derivative of the Armstrong-Siddeley Sapphire. The reliability of this engine was greatly improved by Wright in the course of development for qualification, obtained in February 1954; and few parts remained common with the Sapphire. Later, thrust was boosted to 7,800 pounds, and thousands were used on a variety of aircraft. Thousands were built, saving the Wright Corporation for a while longer; it was the corporation's last significant engine. Wright disappeared from the aircraft industry with the same rapidity as Curtiss.

Daimler Benz

Daimler was the parent company of Mercedes, which with Benz had been one of the two premier German aircraft engine manufacturers during World War I. A merger in 1926 created Daimler Benz. The company built large engines for aircraft and airships but is most famous for the line of engines it created for use in World War II. These included the DB-600 and DB-601 series, the principal inline engines for German fighters and bombers at the beginning of the war. The Messerschmitt Bf 109 was a principal user and saw its Daimler Benz engines grow from 1,100 hp in the 601A to 2,000 hp in the 605.

De Havilland

Geoffrey de Havilland built his first engine in 1903 for a motorcycle and designed his first aero engine in 1908 (a four-cylinder design built by Iris Motor Company). In 1927, de Havilland collaborated with Frank Halford to design the 319-cubic-inch upright Gipsy four-cylinder inline air-cooled direct-drive engine delivering 98 shp (135 shp for racing) at 285 pounds for a large number of small pleasure and training aircraft; 19,548 were installed. The Gipsy was inverted, bored, and stroked to 415 cubic inches, delivering up to 220 shp at 410 pounds when turbocharged. It was developed into the Gipsy 6 and Gipsy 12 engines.

In January 1941, de Havilland began studies of gas-turbine engines and had completed design of the 3,000-pound-thrust Goblin engine in August, with the engine running in April 1942. It was flown in March 1943 in the Gloster Meteor fighter. It flew in the prototype Lockheed P-80 in January 1944 and was licensed to Svenska Flygmotor as the RM1 for the Saab J-21 fighter; 2,688 Goblins were built.

The Goblin was scaled up to become the Ghost, a 5,200-pound-thrust engine used on the de Havilland Venom series of fighters. It was licensed to Svenska Flygmotor as the RM2 for the Saab J-29 fighter; 2,035 Ghosts were built.

De Havilland built versions of the Gyron engine in small numbers before being absorbed into Bristol-Siddeley Engines in November 1961.

General Electric

In September 1941, the U.S. Army negotiated with the British government for rights to the Whittle engine and awarded that program to the General Electric (GE) turbocharger group in September 1941. General Electric developed the J33 and J35 engines. The J33 ran on 9 January 1944. It delivered 4,200 pounds/thrust and flew in the Lockheed XP-80A and other aircraft. The J35 ran first on 2 April 1944 and was installed in a variety of fighter and bomber aircraft. GE delivered 300 production J33s and 140 production J35s by September 1946, when responsibility for both engines was shifted to Allison.

GE's more advanced J47 program was a huge success, with 36,500 being produced through 1956 for the Republic F-84, North American F-86, Boeing B-47, and many other aircraft. A whole series of single-spool axial-flow engines followed, including the J53, J73, J79, T58, J85, T64, J87, J93, and J97. By 1960, GE had established itself as one of the world's premier engine manufacturers.

One notable success was the J79 for supersonic aircraft, started in October 1952 under the leadership of Gerhard Neumann. It featured variable vanes, which became a feature of all future GE engines. The J79 was selected for the Lockheed F-104, Convair B-58, Grumman F11F-1F, McDonnell F-4, and Douglas A-5 aircraft, as well as the Regulus II missile. The greatest production was for the F-4 and F-104; 17,309 engines being built by GE, plus others in Europe and Japan. The last engines were rated at 17,900 pounds/thrust.

The T58 started development in June 1953 as a rear-drive free-turbine. The T58 was qualified in November 1957 at 1,024 shp and was selected for the Kaman UH-2A, Sikorsky SH-3A, Boeing-Vertol CH-46A, the Bell UH-1F, and other military and commercial variants of these helicopters. The T58 was developed to 1,870 shp and 440 pounds; the last of 8,536 T58s was produced in 1988.

At the time GE started the T58, it also started studies of a 2,500-shp engine, finalizing the design in 1957 as the T64. The development program was started that May for both prop- and shaft-drive versions with a goal of 2,650 shp at 1,161, 887, and 723 pounds for the prop-, shaft-, and direct-drive versions. The T64 flew in the de Havilland Caribou in May 1960, and power was increased to 2,850 shp prior to qualification in June 1963. It was also selected for the CH-53, de Havilland Buffalo, Fiat G.222, Lockheed AH-56 helicopter, and Shin Mei Wa PS-1 flying boat and reengined the Japanese P-2 patrol aircraft. Although problems delayed initial qualification, the T64 was uprated to more than 5,000 shp with little weight change; 3,215 engines having been built.

In late 1954, GE began the J85 program as a low-cost lightweight single-spool missile engine with a new six-stage compressor and combustor and two-stage turbine derived from the T58. It flew first as an engine for the Quail missile and was then rated for use in the Northrop F-5 and T-38 programs. It became a popular engine for executive aircraft.

GE participated in the 1962 USAF studies that defined the C-X transport, later to become the Lockheed C-5, for which the TF39 was built. GE built 469 TF39s, which were later uprated to 43,000 pounds/thrust; the TF39 became the basis for the civil CF6 series of engines, of which only a few were in military service as the F103 for the McDonnell Douglas KC-10 and Boeing E-4.

In 1963, GE began studies of the two-spool turbofan that became the TF34. It was selected for the Lockheed S-3A patrol and (slightly derated for improved life) Fairchild-Republic A-10 attack aircraft. More than 2,100 TF34s were built; the civil version, the CF34, has significant production for larger business and regional jet aircraft, extending well into the twenty-first century.

The GE F101 afterburning two-spool turbofan engine started development in August 1968 as the GE9 (X370) demonstrator for the advanced bomber study that became the B-1, running in 1969. This lead to the F101 program, kicked off in 1970, with a goal of 30,750 pounds/thrust. The F110 engine was a redeveloped F101 for the fighter mission. It was initially rated at 27,846 pounds/thrust and 3,980 pounds/weight and was selected for reengining the Grumman F-14 and General Dynamics F-16 fighters. Some 2,800 of the F101/F110/F118 family had been built by mid-1994. The F118 engine for the Northrop B-2 bomber was a non-afterburning version of the F110, with a new fan, and rated at 19,000 pounds/thrust at 3,363 pounds/weight. About 100 F118 engines were produced for the B-2. It has been proposed to re-engine the U-2/TR-2 aircraft with F118 engines.

Another derivative of the F101 was the CFM56 engine, the program starting in December 1971 as a joint venture with SNECMA; it was used in many civil transport aircraft and to re-engine (as the F108) the Boeing KC-135 fleet. The CFM56 substituted a high-BPR (bypass ratio) fan for the F101's low-BPR fan and was certified at 24,000 pounds/thrust and 4,610 pounds/weight in November 1979. Growth versions had reached 34,000 pounds/thrust at 5,700 pounds/weight by the time CFM56 no. 10,000 was produced in June 1999.

GE's two-spool axial-flow afterburning J101 turbojet engine was started in April 1971 and first ran in July 1972. It was intended for the lightweight fighter program; only flight-test quantities were built to fly in the YF-17, but this became the core for the F404 engine, started in March 1975 for the F-18. Volvo further developed the F404 to 18,100 pounds/thrust and 2,315 pounds/weight for Saab's JAS 39 "Gripen" fighter; U.S. development has continued as the F414 for the F18E/F, at 22,000 pounds/thrust and 2,445 pounds/weight (with 150-hour test qualification in October 1996).

GE started the T700 front-drive free-turbine helicopter engine after having run the GE12 demonstrator in 1969, with the T700 started in March 1972 at a goal of 1,500 shp at 400 pounds/weight. This was the first Army engine to have high priority set on maintainability. First run was in February 1973; more than 10,000 engines of the T700/CT7 family have been produced.

General Electric was contracted in 1990 to continue slow-paced further development of the F120 as a backup/alternate engine for the F119 for the next-generation fighter; and when the studies began, GE participated. In 1996, GE was contracted to develop the F120-FX as a backup for the JSF119, but at a slower pace. The F120 development was to focus on engine core technologies during the 1990s and include the same fan and exhaust system variants as the F119 in a demonstration program to start in 2000. It is expected that the GE effort will also tailor the F120 more directly for the needs of the F-24.

Napier

The firm D. Napier and Son manufactured automobiles and engines when, in 1915, the British Air Ministry requested it begin building Royal Aircraft Factory 3a V-12 liquid-cooled engines and Sunbeam Arab V-8 liquid-cooled engines. Believing it could do better, Napier initiated its own engine program in 1916. The first engine was the E64 Lion, developed by A. J. Rowledge. It was of advanced design, being a geared, naturally aspirated (unsupercharged), liquid-cooled engine of W-12 configuration (three banks of four cylinders each, one bank vertical, the others 45 degrees from it). It had double-overhead camshafts, four valves per cylinder, individual cylinders (the first prototypes had monoblock cylinders), and a single cylinder head for each bank. Some 800 Lions were produced through 1932 and were selected for 59 different military and civil aircraft models, including bombers, transports, seaplanes, fighters, and racers.

In 1928, Napier contracted Frank B. Halford to design three air-cooled engines—the H-16 Rapier, the I-6 Javelin, and the H-24 Dagger. Production in small quantities continued into World War II. In 1935, Halford designed the E107 Sabre H-24 double-crankshaft supercharged liquid-cooled sleeve-valve monoblock engine of 2,238-cubic-inch displacement. It was selected for the Hawker Typhoon, Tempest, and Fury fighters, ultimately developing 3,500 shp with water-methanol augmentation. In January 1945, Napier began design of the ultimate in piston-engine efficiency, a 5,000-shp H-24 diesel of 4,571-cubic-inch displacement. Six engines were built and 1,370 test hours were run before the program was canceled in 1955.

After some early disappointments with turbine-engine development, Napier began production of the Eland single-spool turboprop for a rating of 2,750 shp. The initial applications were for reengining of piston-engine aircraft, and the Eland was selected for the Convair 340 (renamed 540), having been demonstrated in the Avro Tudor, Airspeed Ambassador, and Vickers Varsity transports. Later, the Eland was selected for the Fairey Rotodyne and Westland Westminster helicopters. Another helicopter engine was the Gazelle, used in the Bristol Belvedere. Napier was absorbed into Rolls-Royce in the early 1960s.

Pratt and Whitney

In mid-1925, Wright's reluctance to invest in research and development caused its president, F. W. Rentschler, to resign and form Pratt and Whitney Aircraft (named after its benefactor, the Pratt and Whitney Machine Tool Company of

In 1935, Frank B. Halford designed the E107 Sabre H-24 double-crankshaft supercharged liquid-cooled sleeve-valve monoblock engine of 2,238 cubic-inch displacement. It was selected for the Hawker Typhoon, Tempest, and Fury (shown here), ultimately developing 3500-shp with water-methanol augmentation. (Walter J. Boyne)

Hartford, Conn.). Pratt and Whitney's first product was the nine-cylinder R-1340 Wasp, the largest and most powerful U.S. radial engine in 1926 at 425 shp and 650 pounds/weight. Pratt and Whitney immediately followed this with the nine-cylinder R-1690 and R-1860 Hornets; the Navy and then the Army quickly replaced liquid-cooled engines and/or installed these air-cooled engines in as many of their aircraft as practicable. By 1932, the services were primarily using air-cooled engines.

Pratt and Whitney embarked on twin-row radial development in late 1929, leading to the R-1535 and R-1830 twin-row 14-cylinder radial engines. The R-1535 Twin Wasp Jr. began at 600 shp and was produced into World War II at powers up to 825 shp; 2,880 were built. It powered the Grumman biplane fighters, the Hughes Racer, the Vought Vindicator, and others. The R-1830 Twin Wasp had the greatest production run (173,618) of any aircraft engine. It started at 750 shp and quickly grew to 1,000 shp with single-stage supercharging in 1936 for the Seversky P-35 and Curtiss P-36. The basic R-1830 powered most of the C-47s produced. The R-1830, with a single-stage supercharger and a turbocharger, powered 19,000 B-24 bombers and the B-17 prototype. It ran with two-speed, two-stage supercharging before 1940, being qualified before the Allison V-1710 and Rolls-Royce Merlin two-stage programs had started; production versions with intercooling powered the first production Grumman F4F-3 Wildcat at 1,200 shp.

Pratt and Whitney followed the R-1830 with the R-2180 Twin Hornet (a bored and stroked R-1830) at 1,150 shp for the DC-4E and the R-2000 Twin Wasp D (an overbored R-1830) at 1,200 shp for the C-54 (DC-4). These were early examples of engines tailored for a specific airframe; 10,448 R-2000s were built.

The R-2800 Double Wasp 18-cylinder twin-row radial ran in August 1937 and was qualified in 1940 at 1,850 shp at 2,150 pounds/weight. In six months it was rated at 2,000 shp and reached 2,500 shp by the end of World War II. R-2800s were built until 1960 and were in airline service through the 1960s. The R-2800 was an evolutionary design, using improved cylinder design, materials, and baffling to get significant improvement in cylinder cooling technology and was the first air-cooled engine to deliver more than 100 shp per cylinder. The R-2800 used a two-stage supercharger in most fighter applications, and one model used two first-stage superchargers mounted on each side of the engine. More than 114,000 R-2800s were built during World War II.

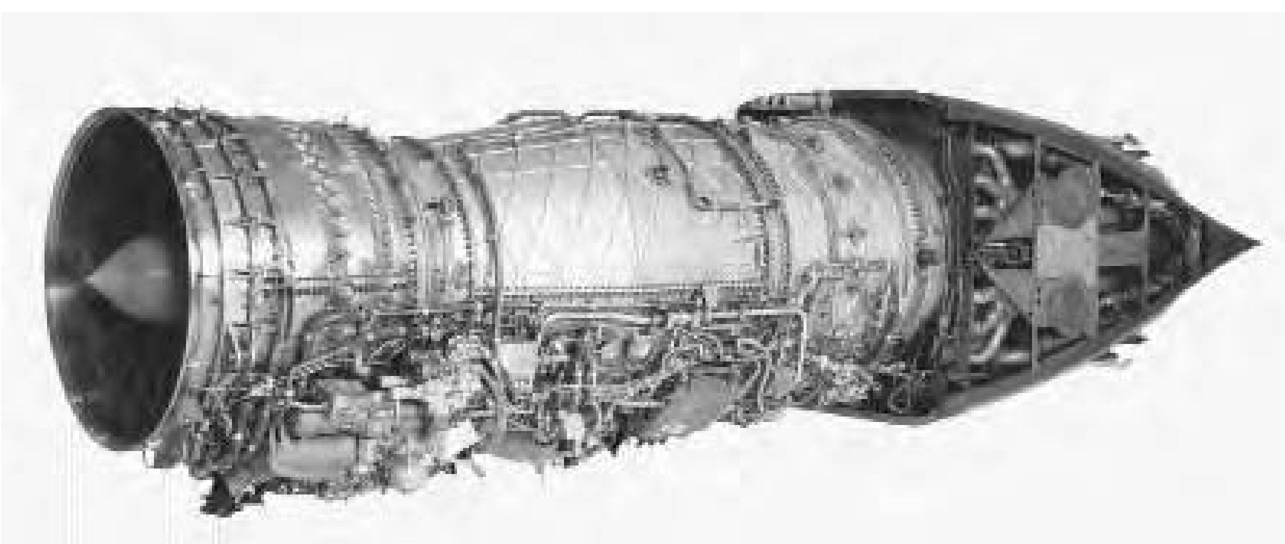
The R-4360 Wasp Major 28-cylinder four-row radial was the only successful large air-cooled engine to be started by the United States in the 1940s. The Pratt and Whitney R-4360 Wasp Major was the largest piston engine to be mass-produced (larger engines were built elsewhere but did not have significant production). Its four rows of seven cylinders were of conventional design, and the engine drew much from the R-2800. Its development was difficult in spite of the conservative approach, and it was not qualified until August 1943. The R-4360 was selected for the many large aircraft, including the Boeing B-50 and Consolidated B-36.

In July 1946, Pratt and Whitney started negotiations with Rolls-Royce and obtained licenses in May 1947 for the Nene and the Tay. The Nene became the J42 at 5,000 pounds/thrust, with 1,139 built for the Grumman F9F Panther. The Tay became the J48 at 6250 pounds/thrust (with 4,108 built for the F9F-6 Cougar, North American F-86D, and Lockheed F-94C over 11 years). Pratt and Whitney spent significant effort making them suitable for production and used its own design for the accessory section and controls in the J48. Later, Pratt and Whitney developed an afterburner for the J48, raising its thrust to 8,750 pounds.

Pratt and Whitney's next great success was the two-spool J57 that powered fighters, bombers, and transports. The last of 21,186 J57s was built in 1965. It was scaled up to the J75, which was also used in advanced fighters and airliners. After building several very large engines, including the J58 for the Lockheed A-12, Pratt and Whitney began the JT3D/TF33 program in 1958. Although only 8,600 JT3Ds were produced (most of them conversions), this engine revolutionized the airline industry and greatly extended the life of the B-52 and, later, the C-135. The TF33 was developed to 21,000 pounds/thrust and was in limited production into the 1990s. Pratt and Whitney started the JT8D engine program in April 1960, which was followed by the JT9D in August 1965 for the Boeing 747. This was followed by the Pratt and Whitney F100 afterburning two-spool turbofan that was selected for the General Dynamics F-16 fighter in 1972. More than 6,000 F100s had been built by the early 1990s. These engines were followed by the Pratt and Whitney F117 (PW2037) transport engine for the Boeing 757 and the McDonnell-Douglas C-17, the Pratt and Whitney F119 (PW5000) afterburning two-spool turbofan engine, with a thrust-vectoring exhaust nozzle, for the Lockheed Martin F-22 and Northrop Grumman F-23, and the development of technology for an engine for the next-generation F-24 fighter in the early 1990s

Rolls-Royce

Rolls-Royce was ordered by the British War Office to start building aero engines—the V-8 designs of the Royal Aircraft Factory and Renault—in August 1914. Believing that a better engine could be built, and with encouragement from the British Admiralty, Rolls-Royce started design of its first aero engine, the Eagle, with a goal of 200 shp. It was a separate-cylinder liquid-cooled V-12 of 1,283-cubic-inch displace-



The Pratt and Whitney F119 engine powers the Lockheed Martin F-22 Raptor and, with augmented power, puts out 39,000 pounds of thrust. (U.S. Air Force) ment, had epicyclic reduction gear, and was not supercharged. The Eagle first ran in late February 1915, flew in December, and was delivered in production by June 1916 at ratings of 225–255 shp at 820 pounds/weight. Its first applications were the FE-2d patrol plane and the O/100 bomber. The Eagle was later selected for the O/400 and V/1500 bombers, the D.H. 4 patrol plane, Felixstowe large flying boats, and numerous other aircraft. After World War I, the Eagle was further developed and was applied to bombers, flying boats, and transports, including the Vickers Vimy. Its highest rating was 375 shp at 847 pounds/weight; 4,675 Eagles were built, some staying in service until 1930.

The Falcon engine was a scaled-down Eagle, having all of its features and displacement of 867 cubic inches. It was intended for fighters and initially rated at 190 shp. The Falcon was initially installed in the Bristol F.2B two-seat fighter, its principal application (more than 3,500 built with Falcons), which remained in service until 1932. Falcons were also installed in Avro, Blackburn, de Havilland, Fairey, Martinsyde, Parnall, Royal Aircraft Factory, Vickers, and Westland fighter, seaplane, and transport aircraft.

The Condor engine was a scaled-up Eagle, at 600 shp the world's most powerful engine. The Condor was the first Rolls-Royce engine with four valves per cylinder, and it went into service in 1920. It powered many aircraft and the R-100 airship. Postwar Condors were redesigned. This effort reduced weight, which declined in steps to 1,200 pounds/weight; 327 Condors were built, the last rated at 750 shp. Two experimental diesel versions were built, as was a turbocharged version, neither leading to production.

The supremacy of the Curtiss D-12 engine shook the British engine establishment, with Fairey obtaining a license to produce it in Britain. The Ministry of Supply refused to support Fairey's endeavor, buying a token amount for the Fairey Fox bomber, which was faster than the fighters of the time. Rolls-Royce was persuaded to develop a D-12 lookalike, named the Kestrel; the last Kestrel (of 4,750 total) was produced in 1938; it had been used in 80 different aircraft.

Rolls-Royce began design of the R engine for Schneider Trophy racing planes in November 1928. For the 1931 Schneider race, the R was thoroughly redesigned to uprate it to 2,350 shp, taking the trophy in September.

To provide still greater power for fighter and bomber aircraft, the Kestrel was scaled up to become the famous Merlin. Design started without government sponsorship in October 1932 as the PV-12. The first production engine, delivered in August 1937 for the Hawker Hurricane, was rated at 890 shp for takeoff, 990 shp at 12,250 feet altitude, and 1,030 shp emergency/combat at 16,250 feet.

A switch from 87 octane to 100 octane fuel in March 1940 allowed the Merlins to be uprated by approximately 30 percent. In a 15-minute 1944 demonstration, a Merlin gave 2,640 shp. Including U.S. production by Packard, approximately 150,000 Merlins were built through 1949.

The Griffon was a growth version of the Merlin and first ran in November 1939, entering service at 1720 shp. Further development of the Griffon resulted in takeoff rating at 2,500-shp with water injection; some 8,100 Griffons were produced through 1955.

Rolls-Royce entered the jet age supporting the Whittle W.2 program and accepted a subcontract for six W.2B engines as WR-1s in the Spring of 1942, running two in November 1942. Then, Rolls-Royce took over the Rover program for the Whittle W.2B engine in January 1943 and improved it as the Welland for the Meteor fighter.

When Rolls-Royce learned that GE was developing the J33 and J35 engines for 4,000 pounds/thrust, it started the Nene program in May 1944. The Nene powered the Supermarine Attacker and Hawker Sea Hawk fighters, several U.K. and foreign prototype and research aircraft, and was licensed to the United States (Pratt and Whitney) as the J42. It served as the basis for the Soviet Union's jet-engine program when export versions were copied as the RD-45.

In April 1945, design began for a single-spool turboprop called the RB.53 Dart. It was selected for the Vickers Viscount airliner and many other aircraft; the last of 7,100 Darts was delivered in 1987.

The Dart was followed by the Tyne, a more powerful two-spool turboprop that powered large transport aircraft, including the Canadair CL-44. It was still being produced in 1994 after more than 900 engines had been delivered.

The Rolls-Royce Avon first saw service in 1950, when it was produced for the English Electric Canberra. Uprated to 7,500 pounds/thrust, it was used in the Vickers Valiant bomber, Hawker Hunter fighter and de Havilland Comet II, among many others. The Avon was adaptable and ultimately developed more than 16,000 pounds/thrust with afterburner; 10,433 Avons were built for aircraft propulsion, plus many more for industrial and marine power.

By now confident in its approach, Rolls-Royce developed the Conway bypass (turbofan) engines. After trial periods, it was certified in September 1958 at 17,500 pounds/thrust, the world's first production turbofan. Production began for the large airliners; 907 Conways were produced.

In the early 1950s, Rolls-Royce began working with vertical-takeoff rigs to understand their control problems—looking toward vertical takeoff and landing of manned aircraft—and designed a long series of lift engines, including the RB.108, RB.145, RB.162, RB.189, RB.198 and RB.202. This series of engines showed what was possible in achieving high thrust-to-weight ratios and benefited later programs.

In June 1961, development continued on the Rolls-Royce Spey engine, which ultimately powered both fighter and patrol aircraft. The engine was licensed to the People's Republic of China in the mid-1970s, where it was built as the WP-9. Approximately 5,500 Spey and derivative engines have been produced.

The RB.172 Adour first ran in May 1967 and was selected for the British Aerospace Hawk trainer and light attack aircraft in 1975. It has been developed to 6,300 pounds/thrust.

In September 1969, after several years of studies, Rolls-Royce started development of the RB.199 three-spool afterburning turbofan (the engine chosen for the Panavia Tornado fighter-attack aircraft, in a joint venture with Moteren und Turbine Union, München Gmbh [MTU], and Fiat, called Turbo-Union). The RB.199 was uprated in steps to 16,900 pounds/thrust with afterburner. Approximately 1,900 RB.199s were produced.

In September 1986, after several years of studies, Rolls-Royce started development of the EJ.200 two-spool afterburning turbofan engine (for the Eurofighter Typhoon fighter) in a joint venture with MTU, Fiat, and Senera, called Eurojet Engines. The first engine run was in November 1988. and the 150-hour type-test was completed in October 1999, illustrating the long development period required for modern jet engines.

Douglas G. Culy

See also

Liberty Engine

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English Electric Aircraft

British aircraft manufacturer. The English Electric Company was founded in 1918 by three disparate companies that had produced aircraft for the Royal Flying Corps and the Royal Naval Air Service during World War I. Its first products were a series of flying boats and a single-seat ultralight, the Wren, in 1923.

In 1926, the company suspended aircraft-building operations. However, the threat of war saw the resumption of manufacturing when subcontracts were placed for various types. Throughout World War II, the company built and repaired Hampden and Halifax bombers for the RAF. After the war, English Electric landed contracts to produce various versions of the de Havilland Vampire under license.

The company finally moved into the design business with the Canberra bomber. Designed by W. E. W. Petter, the prototype first flew in May 1949. A total of 631 aircraft were built by the parent company, with others being assembled under contract, including some in Australia. Such was the success of the Canberra that it was chosen to be built for the USAF as the Martin B-57.

English Electric next designed the Lightning supersonic fighter, which managed to evade the cuts imposed by the 1957 Defence White Paper that advocated replacing manned aircraft with missiles. Eventually, the Lightning went on to serve with the RAF in six different variants. Overseas, the Lightning served with the air forces of Saudi Arabia and Kuwait.

The company's final military project was the TSR.2 (Tactical Strike Reconnaissance). The aircraft proved successful, although political interference and cost overruns finally saw the project canceled. The English Electric name finally disappeared when the company was absorbed by the British Aircraft Corporation in 1964.

Kev Darling

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The English Electra Canberra proved to be one of the most efficient and longest-lived attack aircraft in history. (Kev Darling)

English Electric Canberra

The first jet bomber to be produced in Britain and the first to enter military service. In common with its RAF predecessor, the de Havilland Mosquito, the Canberra flew its missions unarmed at high altitude and at high speed.

Originally intended for radar bombing, the Canberra eventually emerged as a three-seat visual bomber. The prototype, VN799, made its maiden flight in April 1953. Service deliveries began to No. 101 Squadron in May 1951. Such was the demand for the aircraft that subcontracts were placed with Avro, Handley Page, and Short. Eventually, 25 squadrons received the Canberra.

There were many developments of the aircraft, including the T.4 trainer and various upgrades of the bomber versions for use in the Far East and Middle East. An intruder version complete with gunpack was later deployed to Germany.

The Canberra also conducted photoreconnaissance. First developments were based on the bomber, although the final variant featured modified wings and fuselage complete with fighter-type canopy. This final variant was known as the PR.9 and is still in RAF service.

Possibly the greatest coup for any British aircraft was the Canberra's sale to the United States. Built under license by Martin Aircraft, the B-57 Canberra went on to see war service in Vietnam in numerous guises and also served with Pakistan's air force.

Sales overseas for English Electric were also extensive, with countries such as Australia, India, and Sweden, as well as numerous Latin American nations, purchasing quantities. Most are now retired.

Kev Darling

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English Electric Lightning

British fighter. In common with a great many aviation projects during the 1950s, the English Electric Lightning was dogged throughout its development and service career by political interference. However, so correct was the design that it eventually won through.

The Lightning concept owes its birth to German aviation-industries research into swept-wing technology during World War II. Another factor that influenced the design was the lack of a fighter in RAF service that could counter the bombers of the potential enemy, the Soviet Union.

Development of the Lightning began in 1947 when a team led by W.E.W. Petter began research into a supersonic research aircraft. The fruits of their labor first flew as the P.1A in August 1954. Judged successful, the design was further developed into the service version via the P.1B interim experimental fighter.

The RAF received its first service aircraft in July 1960 when No. 74 Squadron was equipped. As the type was developed through the various marks, more squadrons replaced their outdated equipment with the Lightning. Not only were the units of Fighter Command (later Strike Command) equipped; aircraft were also deployed to squadrons in Germany, the Middle East, and the Far East.

Developments to the design included changes to the wing planform that improved stability and allowed an increased fuel load. Improvements to the radar, weapons, and guidance systems extended the Lightning's capabilities. As the aircraft was originally designed for point-defense work, range was extremely short. To counteract this, an underwing refueling probe was installed, as were overwing wing fuel tanks on the last mark, the F.6.

Sales overseas were eventually limited to Saudi Arabia and Kuwait, attempts to sell to such countries as Nicaragua and Venezuela failing for various reasons. Saudi Arabia eventually replaced its Lightnings with the Tornado F.3; Kuwait reequipped with the easier to operate French Mirage F.1.

The RAF rundown of its Lightning fleet was gradual as squadrons reequipped with the Phantom and later the Tornado. By the early 1980s, only two units flew the type until they too changed to the Tornado F.3.

Kev Darling

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Enlisted Pilots in U.S. Military Services

Enlisted and noncommissioned pilots were prominent in many of the world's major air forces. However, the vast majority of pilots in the United States military have been commissioned officers. Nonetheless, enlisted pilots played a significant role in the U.S. military in the years through World War II.

Sergeant William Ivy was probably the first enlisted pilot. In June 1898, during the Spanish-American War, he took an observer aloft in a balloon to report on the Spanish fleet in the harbor of Santiago, Cuba. In 1907, the Army created an aeronautical division to work with "all matters pertaining to military ballooning, air machines, and kindred subjects." At least two enlisted men were part of this earliest incarnation of today's U.S. Air Force.

In 1912, Captain Frank P. Lahm, commander of a newly opened U.S. Army air school in the Philippines, had trouble finding enough officers to train; Corporal Vernon L. Burge, who had been assigned to the aeronautical division earlier, volunteered and became certified as the first enlisted pilot. That same year, it is believed that Harold H. Karr became the first U.S. Navy enlisted pilot, though he did not receive an official naval aviation pilot (NAP) rating until 1920. Some undeterminable, though small, number of Army, Navy, and U.S. Marine Corps pilots served in combat during World War I; many received commissions during their tour of duty.

During the interwar years, two enlisted pilots, Alva Harvey and Henry Ogden, participated in the Army's 1924 round-the-world flight. Harvey, flying with expedition commander Frederick Martin, crashed in Alaska and did not complete the trip; Ogden's plane went down in the North Atlantic, but he completed the circumnavigation. The 1926 National Defense Act required that 20 percent of pilots assigned to tactical squadrons in the Army Air Corps be enlisted; 30 percent of Navy pilots were supposed to be enlisted, though this figure was reduced to 20 percent in 1932. In neither service did the actual number of enlisted pilots come close to those percentages.

As the nation's leaders prepared for World War II, Congress passed Public Law 99 in June 1941 specifically authorizing the creation of a wartime enlisted pilot training program. A few months later, the first class of Army enlisted pilots, who gained popularity as "flying sergeants," reported to primary flying school. The enlisted students of Class 42-C finished their training and graduated on 7 March 1942, one half from Kelly Field, near San Antonio, and the other from Ellington Field, near Houston. They all went on to fly P-38s during World War II. Subsequent classes were assigned to various types of aircraft in both combat and support units.

The Army's sergeant pilot program ended in July 1942 with the passage of Public Law 658. This legislation created the title of "flight officer" in an attempt to lessen the divide between officer and enlisted pilots. Qualification standards for both the enlisted pilot and aviation cadet programs were made equal, and enlisted flying training graduates gained the rank of flight officer or second lieutenant at graduation, depending on class standing. Between 1912 and 1942, nearly 3,000 enlisted pilots, ranging from private through master sergeant, earned their wings and flew for the Army. Of these, 155 were killed in action during World War II. Seventeen became aces, and 11 went on to attain the rank of general officer. At the time of the creation of the USAF in 1947, two pilots reverted to their enlisted ranks and became the only flying sergeants in the new service.

Over the years, as many as 5,000 enlisted men may have served as pilots with the Navy, Marines, and Coast Guard. Legislation ended the enlisted naval pilot program in 1947. Master Chief Robert K. Jones, the last enlisted NAP and the last serving enlisted pilot in the U.S. military, retired in 1981 after 38 years of service. Among the Navy's World War II heroes, Machinist Donald E. Runyon was credited with eight kills during World War II, including four on one day, before he became a commissioned officer. Runyon finished the war with 11 victories. Marine Corps Medal of Honor winner Ken Walsh started his career as an enlisted pilot and went on to become one of the leading American aces of World War II with 21 kills.

Many notable pilots started out in the enlisted ranks. William Ocker, an enlisted pilot during World War I, helped pioneer instrument flying. Walter Beech, cofounder of Beech Aircraft Corporation and a member of the National Aviation Hall of Fame, served as a sergeant pilot in World War I. Another Aviation Hall of Fame pilot, Bob Hoover, served as an enlisted pilot during World War II and is considered one of the great test pilots of any era. Sergeant pilot Ralph Bottriell earned the Distinguished Flying Cross for his work with parachutes.

Bruce A. Ashcroft

See also

Aces, leading; U.S. Army Aviation (Operations); U.S. Marine Corps Aviation; United States Navy, and Aviation; World War I Aviation; World War II Aviation

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Enola Gay

The U.S. heavy bomber that dropped the first atomic weapon over Japan. A Boeing B-29–46-MO, serial number 44–76292, *Enola Gay* was one of a block of Martin-Omaha B-29s that were especially built without fuselage turrets to lighten the airframe and permit higher airspeeds. Curtiss electric propellers were installed in lieu of the usual Hamilton Standard hydromatics. The forward bomb bay was modified by the addition of an H-frame support and a British-designed C-mount used to carry massive 22,000-pound conventional Tallboy bombs. These airplanes were all assigned to the 393d Bomb Squadron, 509th Bombardment Group (Very Heavy).

The unit trained at Wendover Field, Utah, where it practiced dropping massive dummy bombs (known as "pumpkins") in preparation for dropping the large and heavy atomic bombs. The *Enola Gay* was the personal aircraft of the group commander, Colonel Paul W. Tibbets, and was named for his mother.

The 509th Bombardment Group deployed to North Field, Guam, where it was attached to the 313th Bombardment

The most famous Boeing B-29 in the world is the Enola Gay. *The combination of the B-29 and the atomic bomb was the ultimate expression of air power. (U.S. Air Force)*

Wing. Crews flew in formation with other bomb groups in the Mariana Islands for familiarization.

On 6 August 1945, Colonel Tibbets and his crew flew the *Enola Gay* to the Japanese home islands and dropped the world's first atomic weapon—code-named "Little Boy"—on the city of Hiroshima.

The *Enola Gay* is now in the collection of the National Air and Space Museum of the Smithsonian Institution.

Alwyn T. Lloyd

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Ethiopian War

Italian attack on Ethiopia on 3 October 1935; the last European drive to gain African colonies. Italy had prepared thoroughly, its Regia Aeronautica (the air force) receiving massive funding for new aircraft and a huge logistic organization. To preserve home forces, each squadron sent to Ethiopia left behind a so-called *bis* unit with older aircraft. Thus, the 27th *Stormo* fought in East Africa with Caproni Ca.111s while in Italy a 27th Bis flew Ca.74 and Ca.102s. By May 1936, Italy sent to East Africa 389 aircraft and 309 spare engines; Ethiopia fielded five Potez 25 general-purpose biplanes, four Fokker F.VII transports, and a handful of other types.

The surface campaign was launched from the neighboring Italian colonies of Eritrea (northern front) and Somalia (southern). The Ethiopian capital, Addis Ababa, fell on 5 May 1936; four days later, Mussolini proclaimed the Empire.

The Regia Aeronautica was a decisive factor in the victory. The lack of aerial opposition allowed Italian reconnaissance to track enemy moves. Bombers hit troop concentrations, and airdrops allowed the army to advance through inhospitable terrains. Wherever a lack of refrigerators made it impossible to store meat, live animals were dropped. This close air-ground cooperation relied largely on visual signals—white sheets deployed in conventional patterns, thus obviating the lack of direct radio links.

Ethiopian antiaircraft fire was very effective, hitting about two-thirds of all Italian aircraft. This explains the relatively high aircrew casualties (110 dead, more than 150 wounded), although many resulted from accidents—very dangerous in the harsh environment.

On 27 October 1935, Mussolini authorized the use of gas "as an extreme measure to overcome enemy resistance and in case of counterattacks." The orders were repeated on 16 and 28 December 1935 and on 5 January, 29 March, and 27 April 1936. Gas sorties (132) and bombs dropped (272 tons) represented only 2.6 percent and 18.8 percent of the total, but their effect was often critical: On 19 January 1936, only gas prevented an Ethiopian breakthrough at Uarieu. It is important to note that the decision to use gas was made at the highest political level and not by individual air commanders.

Italy overestimated its African victory, which relied on a superiority unlikely to be repeated; thus the campaign offered more training than stimulus for technological evolution. The war ended officially in May 1936, but extensive insurgency committed the Regia Aeronautica to a long and costly "colonial police" campaign.

Gregory Alegi

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Eurofighter Typhoon

Joint project between the United Kingdom, Germany, Italy, and Spain, with each country being responsible for areas of development and construction. It is intended that the Typhoon will replace various aircraft in the air forces of the participating countries. The types destined to be retired include various versions of the Tornado and Jaguar.

The quest for the Typhoon, regarded as a fourth-generation fighter, began in 1977 when tentative discussions were held between the defense ministers of Britain, France, and Germany. Although these talks did not result in a cooperative venture, they did lay the foundations for the Tornado partners—Britain, Germany, and Italy—to start looking at the so-called Agile Combat Aircraft in 1982 to replace the Tornado. These early discussions resulted in permission to build two test aircraft for the Experimental Aircraft Program (EAP).

Before metal was cut or carbon fiber autoclaved, the project had run into trouble. The German government, caught between two sets of political loyalties to two sets of partners, eventually voted to do nothing. This left British Aerospace to develop the EAP alone. Incorporating all the latest technology advances, including an unstable fly-by-wire system, the single aircraft flew in August 1986. A series of 259 sorties proved the concept of the aircraft before it was grounded in 1991.

The usual intergovernmental wrangling was finally completed in 1985 before the aircraft had flown. The service aircraft was to be known as the "European Fighter Aircraft" and

Due to enter service in 2003, the Eurofighter Typhoon is the result of an uncommon partnership between Spain, the United Kingdom, Germany, and Italy. (Kev Darling)

was planned to consist of 760 units. Work division by percentage was: United Kingdom (33), Germany (33), Italy (21), and Spain (13). Total orders for each nation are: United Kingdom (250), Germany (250), Italy (160), and Spain (100).

Even with program agreement, there were to be political problems, mainly in Germany, as the project underwent evaluation, rejection, and reinstatement almost on a monthly basis. Fortunately, this most advanced of aircraft has not succumbed to the political furor that has occasionally surrounded it. There has also been some export interest with both Greece and Norway, both of whom have made firm commitments. Also looking closely at the Typhoon are Australia and Saudi Arabia. The Eurofighter Typhoon is due to enter service by 2003.

Kev Darling

F

Fairchild A-10 Thunderbolt II

Attack plane; entered USAF operational service in March 1976. It has two General Electric turbofan engines, each capable of 9,064 pounds/thrust. It is 53 feet, 3 inches long, 14 feet, 8 inches high, and has a 57-foot, 6-inch wingspan with a gross weight of 51,000 pounds. Its combat speed is about 440 mph, with a range of 650–800 miles. Its maximum ordnance load is 16,000 pounds. Employing depleted uranium armor-piercing shells, the seven-barrel 30mm GAU-8A rotary cannons mounted in the nose are capable of firing 2,100–4,200 rounds per minute. During the Gulf War, the 144 deployed A-10s flew 8,624 sorties in extreme climate conditions and still maintained a 95.7 percent mission-capable rate.

It has self-sealing fuel tanks, redundant wing spars, widely separated tail-mounted engines, and a manual backup flight control system. These features, as well as 1-inch-thick titanium armor covering vital flight control elements, allowed many A-10s to survive direct hits from Iraqi missiles.

Also nicknamed the "Warthog," the A-10 proved its lethality during Operation DESERT STORM, consistently chewing up Iraqi armor. In one operation, two A-10s destroyed 23 armored vehicles (mostly tanks) in one day. All total, A-10s destroyed 967 tanks, 1,026 pieces of artillery, 1,306 trucks, 281 military structures, 53 Scud missiles, 10 aircraft on the ground, and two in the air.

Besides the GAU-8A cannons, the A-10 can carry a wide variety of "dumb" ordnance on eight underwing and three underfuselage pylon stations. It can also carry laser-guided/electrooptically guided bombs, infrared countermeasure flares, electronic countermeasure chaff, jammer pods, 2.75-inch rockets, and illumination flares.

Today, there are two variants of the Thunderbolt II, the A-10 and the OA-10. The latter is an airborne forward air control platform.

William Head

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Fairchild Aircraft

U.S. aircraft manufacturer. Growing out of Sherman Fairchild's interest in aerial photography, the Fairchild manufacturing firm experienced many name and ownership changes in its history (1925–1988). Known primarily for its trainers and transport aircraft, it operated a Canadian subsidiary in 1922–1948.

The company's first big success was the PT-19/23/26 series of basic trainers, first flown in 1939 and of which more than 7,000 were built (Cornells in Commonwealth service). The C-61 Forwarder single-engine utility aircraft saw some 1,665 built from 1941 to 1944, of which about half went to the RAF. From 1944 to 1948, some 220 C-82 Packet twin-engine cargo aircraft were manufactured. It was followed by the improved C-119 Flying Boxcar, of which 1,087 were manufactured from 1948 to 1953. The smaller C-123 Provider originated as a Kaiser-Frazer design in 1954, but the contract was turned over to Fairchild, which made more than 300 in 1954–1955.

Fairchild had a successful regional airliner project when it purchased a license from Fokker to manufacture the F-27. From 1956 to 1971, the F-27 Friendship and the stretch ver-

Form followed function in the Fairchild A-10 Thunderbolt II, but if the aesthetic result was not the highest, the practical results were. The "Warthog," as it is affectionately known, gained a new lease on life in the Persian Gulf War and will be part of the U.S. Air Force for many years to come. (U.S. Air Force)

sion, the FH-227 (of which 79 were made) totaled 205 aircraft by the time production ceased in Hagerstown, Maryland, in 1971.

Fairchild took over Hiller Helicopter in 1964 and Republic Aviation in 1965 (becoming Fairchild Republic). With the latter purchase came the A-10 Thunderbolt II ground support aircraft, of which more than 700 were manufactured in the 1970s. But after the loss of several further contracts, the firm closed in 1988.

Christopher H. Sterling

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Fairchild C-82 Packet and C-119 Flying Boxcar

U.S.-manufactured cargo haulers. Through to the end of World War II, Allied airlifters were constrained by aircraft that were not designed for swift onloading and offloading of cargo.

Fairchild Aircraft of Hagerstown, Maryland, designed and developed America's first endloading aircraft. Known as the C-82 Packet, the aircraft had tricycle landing gear, thereby offering a level cargo floor. In addition, a pair of clamshell doors were installed at the aft end of the fuselage. With the doors wide open, a special truck with a bed equal to the height of the cargo floor offered unrestricted loading and unloading. For troop carrier operations, the C-82 had troop doors within the sides of the clamshell doors that permitted two sticks of paratroops to jump simultaneously from the aircraft. For heavy cargo drops, the clamshell doors could be removed prior to flight and the cargo could be extracted in flight. Frangible pallets and rigging equipment developed by the U.S. Army Quartermaster Corps permitted heavy cargo, small vehicles, and howitzers to be dropped without sustaining any damage.

Despite some shortcomings, C-82s served well with U.S. forces in post–World War II Europe and permitted the USAF and Army to perfect their airdrop capabilities during exercises within the United States. The C-82s also flew numerous humanitarian missions during natural disasters such as floods and blizzards.

The C-119 Flying Boxcar was developed from the C-82. Both were twin-engine, twin-boom aircraft with a fuselage pod suspended beneath the wing center section. The C-119 was slightly larger but could carry 22,000 pounds more than its predecessor. Problems persisted due to marginal engine-out performance and stability. The stability problems were rectified by the addition of dorsal, and later ventral, fairings on the tailbooms. Engine and later propeller problems continued to plague the aircraft throughout its service life.

When the Korean War erupted in June 1950, only Curtiss C-46s and Douglas C-47s were available as transports in the theater. By August 1950, C-119s began arriving in Japan and were able to fly their first aerial supply missions. Throughout the war, the C-119s bore the brunt of the tactical airlift assignments, performing airlift, airdrop, and paratroop drop missions. One of the most significant missions of the war was flown on 7 December 1950, when eight C-119s each dropped a section of treadway bridge to the "Chosen Frozen," a force of the 1st Marine Division and the remnants of the Army's 31st Infantry Regiment, which had been pinned down and cut off for 13 days. This was the first time a bridge was ever dropped from an aircraft. Of all the aircraft in the USAF inventory, only the C-119 had the capability to perform this mission.

After the Korean War, C-119s became the backbone of the Air Force Reserve troop carrier force, with 45 squadrons equipped with the aircraft. The aircraft served with the Reserve for 19 years.

A new mission was developed for the Flying Boxcar to meet the requirements of the Vietnam War. Fifty-two were converted into AC-119 gunships to fly night interdiction missions with USAF special operations units. Though arriving late in the war, the aircraft performed remarkably well and were most appreciated by friendly forces on the ground.

Alwyn T. Lloyd

See also

Douglas C-47; Special Operations

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Fairchild, Muir Stephen (1894–1950)

U.S. Air Force vice Chief of Staff, airpower theorist, and founder of Air University. Muir "Santy" Fairchild was born on 2 September 1894 in Bellingham, Washington, and began his military career in the Washington National Guard in 1916. Beginning flight training as a flying cadet at Berkeley, California, in 1917, Fairchild completed his training overseas in Europe and earned a commission as a second lieutenant in the Aviation Section in 1918. He flew bombing missions over the Rhine with French forces until the Armistice. Fairchild received a regular commission as a first lieutenant in the Air Service, serving as a test pilot, flight instructor, and engineering officer. Fairchild earned the Distinguished Flying Cross for his participation in the Pan American Goodwill Flight (1926–1927).

Over the course of the 1930s, Fairchild graduated from the Air Corps Tactical School (ACTS, 1935), Army Industrial College (1936), and the Army War College (1937). Fairchild became a member of the ACTS faculty in 1937 and was appointed director of the Department of Air Tactics and Strategy in 1939. During his time at ACTS, Fairchild participated with Donald Wilson in the theoretical development of strategic precision daylight bombing. A colonel at the commencement of World War II, Fairchild experienced rapid promotion to the rank of major general as a result of his contributions in developing U.S. military strategy during the war. Valued for his vision and thinking abilities, Fairchild received prominent assignments that included secretary to the newly created Air Staff (1941), assistant chief of the Air Corps (1941), director of military requirements at the U.S. Army Air Forces Headquarters (1942), and member of the Joint Strategic Survey Committee in the Office of the Combined Chiefs of Staff (1942–1946). After the war, he was also one of the few officers to provide input into the formation of the United Nations. In 1945, Fairchild also successfully lobbied for the creation of a separate military educational system for the USAAF that was designed to study air strategy in a preventative context. Fairchild's reputation as a critical thinker and airpower theorist made him the overwhelming choice to become the first commandant of the USAAF School in February 1946, soon renamed Air University (AU).

During his tenure as AU commandant (1946–1948), Fairchild forged an enduring educational philosophy that integrated the elements of air warfare with both ground and naval warfare in order to create a prevailing military strategy that allowed the United States to influence world affairs. Fairchild's service as AU commandant ended in May 1948 with his appointment to USAF vice Chief of Staff and promotion to four-star general. For this period, Fairchild concentrated on the creation of the Air Force's air defense system, an assignment that became more pertinent with the Soviet Union attaining atomic capabilities. General Fairchild suffered a massive heart attack and died on 17 March 1950 at Fort Myers, Virginia.

Mark R. Grandstaff

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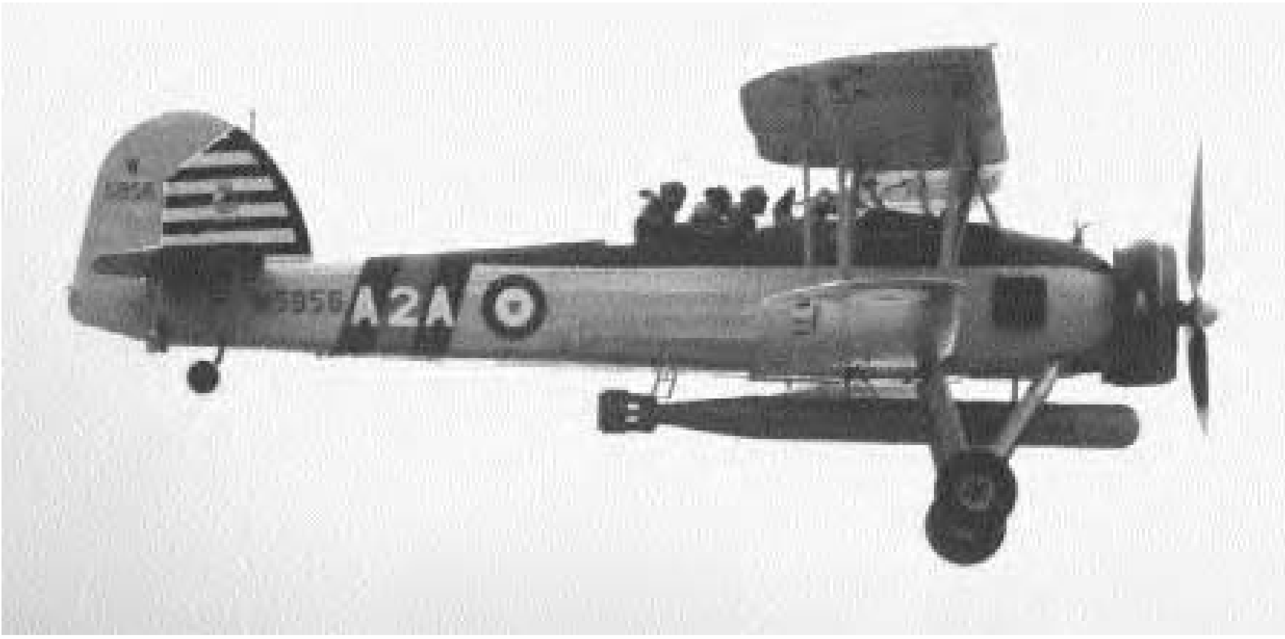
Fairey Aircraft

Founded by Charles Richard Fairey (1887–1956), who worked as an electrical engineer and first entered aviation by building award-winning models. After a stint as chief en-



The Fairey Swordfish, though by the 1940s slow and obsolete, was nonetheless a major factor in World War II, with its strike on the German battleship Bismarck *and its part in the brilliant victory at Taranto. (Big Bird Aviation)*

gineer at the Short aircraft firm, he formed his own company in 1915. Initial output focused on successful seaplanes.

The Fairey III family of biplane fighters was manufactured in various marks from 1917 into the 1930s. The Fairey Fox daytime fighter of 1926 was a handsome metal biplane for the Royal Air Force. From 1930 until 1945, Fairey operated from the Great West Aerodrome at what is now Heathrow Airport outside London. The Swordfish biplane torpedo-bomber of 1934 sank 1 million tons of enemy shipping in World War II; more than 2,400 were manufactured by Fairey and Blackburn. The Battle bomber and Seafox fighter for the Fleet Air Arm were late-1930s products.

During World War II, Fairey manufactured some 2,500 Barracuda torpedo-bombers and well over 1,000 Firefly carrier fighters. Postwar activity centered on the turboprop Gannet antisubmarine and early warning aircraft for the Royal Navy. The two F.D. 2 research aircraft were the world's first to take the absolute speed record over 1,000 mph and were later used in research for the Concorde airliner. The Rotodyne transport of 1957 combined helicopter and normal airplane operation but was terminated before reaching production. Fairey was taken over by Westland in 1960.

Christopher H. Sterling

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Fairey Swordfish

British dive-bomber and torpedo-bomber. Regarded as obsolete at the beginning of World War II, the Swordfish nevertheless went on to serve in the Fleet Air Arm and the RAF until the end of hostilities. The reason for such longevity was its superb handling, especially during landing, torpedo attack runs, and dive-bombing.

A follow-up to the earlier TSR.I, the Swordfish was developed as the TSR.II by Fairey Aircraft, the first one flying in April 1934. Fairey delivered 692 aircraft before handing over production to Blackburn to make way for production of the Albacore, hailed as the replacement for the Swordfish.

Service deliveries of the Swordfish I began in February 1936, with deployments to the various fleet carriers occurring soon after. A further development of the Swordfish, the Mk.II, began to enter service in 1943 and featured a strengthened lower mainplane that was stressed for the carriage of rocket projectiles. The final major production variant was the Swordfish III, which had an uprated Pegasus engine and an air-to-surface-vessel radome located between the main undercarriage legs. A further upgrade saw the appearance of the Swordfish IV, which had an enclosed cockpit for use in Canada.

The Swordfish first came to prominence during the Battle of Narvick when a battleship-launched aircraft spotted a U-boat for the fleet before destroying it itself. In November 1940, the Swordfish was involved in the most famous torpedo attack of all: the immortal strike against the Italian main battle fleet at Taranto Harbor. The Italian fleet suffered great losses that rendered it almost useless for the rest of the war. Further escapades involved the hunting of the German battleship *Bismarck.* For the last three years of the war, the Swordfish operated from the smaller fleet carriers in support of operations during convoy work.

The Swordfish also operated with the RAF for Coastal Command patrol duties. All operational Swordfish flying duties finished with the FAA in June 1945. A few aircraft remained in use for trials and communications use before final retirement ceremonies in 1953.

Kev Darling

Falaise-Argentan Pocket

Support of ground operations and interdiction of enemy retreat during World War II. By mid-August 1944, the American breakout from the western section of the Normandy bridgehead threatened to create a massive encirclement of German forces. The British Second Army and Canadian First Army moved south in an attempt to join with the U.S. First Army and pocket up to 16 German divisions, including the primary remaining mobile forces in France. The defeated German units tried desperately to escape the developing encirclement and moved by daylight along roads and in the open. This offered pilots of the Allied tactical air forces lucrative targets that had been uncommon in recent months.

For an entire week, Allied fighter-bombers and medium bombers pounded the retreating columns at will, wreaking havoc with the German withdrawal and destroying much of the German Seventh Army. Rocket-firing Hawker Typhoons were particularly effective. The Allied advances on the ground were not as successful, however, and German forces that were not destroyed from the air largely escaped.

Scenes of the Falaise killing ground graphically show the awesome effect of airpower on exposed ground targets. Although Allied air attacks caused enormous amounts of destruction, the battle can also show the difficulty in isolating and destroying a retreating army from the air, since the German armies, using cadres that escaped from Falaise-Argentan, were soon able to reform along the German frontier.

Frank E. Watson

Falkland Islands War

Also called the Falklands War, Malvinas War, or the South Atlantic War—a brief undeclared war fought between Argentina and Great Britain in 1982 over the control of a group of islands approximately 300 miles east of the Argentine coast.

The war was the first use of modern cruise missiles against warships of a major naval power. The Argentine Air Force (AAF), using French-built Exocet missiles, sank several British ships, including the destroyer HMS *Sheffield* and the container ship *Atlantic Conveyor.* The Exocet threat to British shipping would have been greater but for the fact that the AAF possessed only five missiles; an arms embargo kept Argentina from purchasing more.

The air war in the Falklands was the first time since World War II that sustained air attacks were made against naval forces at sea. The AAF demonstrated that brave pilots flying less-than-state-of-the-art or unsuitable aircraft could penetrate modern missile defenses and inflict major or even fatal damage on warships. The British were saved the loss of numerous other ships because, by one account, almost 75 percent of Argentine bombs failed to detonate. Four 1,000-pound bombs, none of which exploded, hit the British frigate HMS *Plymouth.*

The Falklands air campaign was the first known use of vertical/short takeoff and landing (V/STOL) aircraft in combat. The British Harrier jump jets, operating off of small carriers, emerged from the conflict with a greatly enhanced reputation. During the war, there were never more than 25 Harriers available in the theater of operations, and therefore the British were outnumbered at least three-to-one by the AAF.

In air-to-air combat, Harriers destroyed 23 aircraft with no Harriers shot down. This discrepancy is a result of several factors, including superior British training, poor tactics on the part of the AAF, and superior British equipment—especially the U.S.-made Sidewinder missile.

Craig T. Cobane

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Far East Air Forces (FEAF)

U.S. Army Air Forces and U.S. Air Force organization controlling forces in the Pacific region. The Far East Air Force (singular) designation was originally assigned to the U.S. Army Air Forces units in the Philippines in October 1941. This organization moved to Australia in February 1942 and was subsequently redesignated the Fifth Air Force.

The structure of the Far East Air Forces (plural) was first created in August 1944 to serve as the senior air headquarters controlling the Fifth and Thirteenth Air Forces in the Southwest Pacific Theater. HQ FEAF also served as headquarters for Allied Air Forces Southwest Pacific. FEAF provided support for Army and Navy forces in the liberation of the Philippine Islands. FEAF operations in the Southwest Pacific emphasized seizing air superiority, disrupting enemy logistical operations, and providing support to Allied surface forces. The Seventh Air Force was reassigned to FEAF from Army Air Forces, Pacific Ocean Areas, on 14 July 1945 as part of the consolidation of all Army forces in the Pacific under General Douglas MacArthur in preparation for the planned invasion of Japan. General George C. Kenney commanded FEAF during World War II.

After World War II, HQ FEAF was assigned to Japan as the Army Air Forces component of Far East Command (FECOM), which was responsible for U.S. military forces in Japan, Korea, the Philippines, and Ryuku, Mariana, and Bonin Islands. When the National Defense Act of 1947 created the Department of Defense and the independent United States Air Force, FEAF became a major command of the USAF while retaining its role as a component of FECOM under the Joint Chiefs of Staff Unified Command Plan. Prior to the Korean War, the major FEAF subordinate units were the Fifth Air Force in Japan, the Twentieth Air Force in Okinawa, and the Thirteenth Air Force in the Philippines.

When the Korean War erupted on 25 June 1951, FEAF assumed responsibility for Air Force combat operations under FECOM and the United Nations Command, working with the other U.S. components—Army Forces Far East and Naval Forces Far East (NAVFE)—and with the Allied forces. General George E. Stratemeyer was the FEAF commander at the start of the war, and after Stratemeyer suffered a heart attack in May 1951, General Otto P. Weyland assumed command for the remainder of the conflict. The major FEAF subordinate combat commands for Korean War operations were Fifth Air Force and FEAF Bomber Command, with airlift operations controlled by the FEAF Combat Cargo Command (designated the 315th Air Division in February 1951) and logistical support provided by Far East Material Command (designated the Far East Air Logistics Force in July 1952). The Fifth Air Force controlled the interceptors, fighters, fighter-bombers, light bombers, and reconnaissance and liaison aircraft.

FEAF Bomber Command controlled the B-29 medium bombers, as well as RB-29 and RB-45 reconnaissance aircraft, provided by the Strategic Air Command. FEAF also controlled the Allied fighter aircraft provided to the UN Command. Conflicting service doctrines on the employment of airpower complicated the task of controlling air activities during the Korean War.

The FEAF commanders followed USAF doctrine and sought centralized control of all air operations to provide the greatest amount of flexibility in the use of all available airpower. However, Navy and Marine leaders resisted this approach and fought to maintain independent operational control of their air assets. Coordination between FEAF and NAVFE and Marine aviation assets evolved through the war, with Naval and Marine operations increasingly integrated into the FEAF/Fifth Air Force plans. Formally, the FECOM Targeting Committee provided broad direction for air operations throughout the conflict, but eventually the FEAF Targeting Committee and the Fifth Air Force Joint Operations Center, which included Navy and Marine representatives, essentially directed all air operations.

After the Korean War, FEAF continued to serve as the air component for FECOM. In 1957, Far East Command was merged into Pacific Command (PACOM), and FEAF became Pacific Air Forces (PACAF), a USAF major command and PACOM's air component. In support of this realignment, the PACAF HQ transferred from Japan to Hawaii.

Jerome V. Martin

See also

Cactus Air Force; Kenney, George C.; Korean War; Leyte Gulf, Battle of; MacArthur, Douglas, and Airpower; Pacific Air Forces; Weyland, Otto P. "Opie"

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Farman Aircraft

Founded by Henri Farman (1874–1958), who had purchased the second aircraft manufactured by the Voisin firm. After painful tests, he successfully took off. Developing the machine, he obtained great success and received an order for two biplanes (designated H.F.) from the French navy in July 1909 and four from the Armée de l'Air. Simultaneously, brother Maurice Farman (1877–1964) built his own models (designated M.F.). Due to the absence of a clear designation system, however, the history of early Farman aircraft is very confusing, as more than 1,500 were produced before World War I for civilian and military purposes.

Used for observation and bombing, the HF.20, HF.30, and many MFs were used extensively by France, Belgium, Great Britain, Italy, Japan, and Russia. The F.40 arrived in 1915 and replaced the former types in 1916. The only advanced bomber designed by Farman, the F.50, was built (171 units) before the end of the war. Thirteen were later obtained by Mexico. A total of 4,164 Farman aircraft were produced during World War I in France alone.

The first F.60 "Goliath" flew just before the Armistice. Launched as a twin-engine big bomber, it was quickly developed as a major commercial aircraft, but many versions were built for military purposes. No less than 600 left the Farman works, being used mostly by French services. They were highly successful in the 1926 Morocco operations. It was followed by the F.220 series, long-range four-engine bombers, 59 of which were delivered to the Armée de l'Air. It was the Farman N.C. (Nord Centre) 223-4—the *Jules Verne*—that achieved the very first raid over Berlin, launching 2 tons of bombs over the city on 8 June 1940 in a symbolic action forecasting more raids to come.

The Farman works had been nationalized in 1936 and became part of Nord Centre. The Farman name disappeared from military aviation after World War II.

Stephane Nicolaou

Farman Pushers

Farman was one of the many French firms that began operations prior to World War I. Another effort by a pair of brothers, Maurice and Henri, Farman aircraft came in two varieties: the H.F. series, designed by brother Henri, and M.F. aircraft, the work of brother Maurice.

The firm manufactured pusher aircraft, featuring large, bathtublike nacelles for the crew; they were used as bombers both in French escadrilles and in British two-seater squadrons. Although the pusher configuration was effective early in the war, Farman held on to it long after its useful days were over. As a consequence, not much was heard of the company in the war's later years, that is, at the front. The training fields were another matter. There the Farman's easy handling characteristics made it a useful primary training machine, and in this role it soldiered on until the Armistice.

James Streckfuss

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Ferrets

Aircraft specifically designed to detect, analyze, and sometimes jam enemy radio and radar stations. During World War II, modifications and training were conducted at Boca Raton, Florida. B-17s and B-24s were converted for this mission. Passive sensors and associated antennas were installed, along with specialized operator stations.

The first Ferret operation was flown against a Japanese radar at Kiska in the Aleutian Islands on 6 March 1943 using a B-24. The Ferret operators were able to define and plot the enemy radar pattern so that a successful P-38 strike could be launched with minimal risk from antiaircraft fire.

Section 22, in the Southwest Pacific, utilized data from a B-24L Ferret assigned to the Thirteenth Air Force. By 1944, Ferret tactics now included detection and plotting as well as jamming with both and radio.

During Operation HUSKY, one of several B-17 Ferrets assigned to the Ninth Air Force was flown to suppress German antiaircraft fire for the parachute invasion of Sicily.

Strategic Air Command continued using Ferrets during the Cold War. RB-29s and RB-50s from the 55th Strategic Reconnaissance Wing regularly probed Soviet defenses around the world. These were followed by RB-47s from that wing.

Unique were the seven RB-69 Neptunes (former USN P2V-7s) procured by the USAF for use by the CIA. The basic production aircraft were modified in the famed Lockheed Skunk Works. The specialized equipment was so heavy that each aircraft was individually built for a specific mission. Though painted Navy blue, the aircraft carried USAF markings, operated out of USAF bases, and were flown by CIA crews.

The U.S. Navy also used Ferrets during World War II, converting PB4Y Privateers and supplementing them with P4M Mercators and P2V Neptunes.

Alwyn T. Lloyd

See also

HUSKY; Strategic Air Command

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Fiat

Founded in Turin, Italy, in 1899 as an automobile manufacturer. Today Fiat is a leading multinational group. FiatAvio, its $1 billion aviation subsidiary active in engine manufacture and overhaul, space propulsion, and energy, traces its origins to 1908.

Before World War I, Fiat built several experimental aircraft and airship power plants. The first production engine was the 100-hp A.10 (1915), patterned upon the Mercedes-Daimler D.I; the more powerful A.12 family (1916) accounted for more than one-half of all World War I engine production in Italy. In 1915, the Italian army invited Fiat to build the Farman M.F. 11 biplane, and in 1916 the new SIA company was formed for aircraft production. The large SIA 14 bomber was a failure, and the single-engine SIA 9 proved disappointing. Worse, the SIA 7, ordered in quantity trusting on the prototype's remarkable performance, suffered fatal structural failures in squadron service and was withdrawn. Enraged, the army in June 1918 called for the withdrawal of all SIA types "past, present, and future" but allowed a new Fiat "Aviazione" to operate under the technical direction of Celestino Rosatelli (1885–1945).

In 1925, Fiat bought Aeronautica Ansaldo, which was renamed Aeronautica d'Italia and became its aircraft division. Aero engines were still built under the Fiat name, powering all Fiat types as well as the Macchi C.72 speed-record seaplane.

Rosatelli conceived 60 types for Fiat, and some 6,000 aircraft were built. They ranged from racers to bombers to transports, but Rosatelli is best known for the CR fighters, which began with the all-wood CR.1 (1923). He introduced metal construction with the CR.20 (1926) and peaked with the CR.32 (1935).

A second design office was established in 1931 for Giuseppe Gabrielli (1903–1987), whose first production type was the lackluster G.50 fighter of 1937. Gabrielli also designed transports that served initially with the airline ALI, a Fiat subsidiary like the CANSA and CMASA factories.

At the outbreak of World War II, Fiat was the largest Italian aviation firm, and its parent company wielded enormous influence. Nevertheless, its contribution to the Italian war effort was disappointing. In the engine field, the inability to go beyond the 1,000-hp A.80 radial forced it to belatedly acquire a license for the Daimler Benz DB.605. The BR.20 twin-engine medium bomber (1935) proved adequate, but the obsolete CR.42 fighter biplane (1938) remained in production until 1943 to become the most widely produced Italian design of World War II. The G.55 monoplane (1942) offered better performance, but only a handful were completed before the Italian armistice. Aircraft production was stopped by U.S. air raids in March–April 1944, although Fiat supplied engines and subassemblies to German industry.

After the war, Fiat rapidly regained its industrial preeminence. Gabrielli designed two jet trainers, the G.80 (1951—the first Italian turbojet aircraft) and G.82 (1954), which did not go beyond the prototype phase, but Fiat was able to enter the jet age by building under license the de Havilland D.H. 100 Vampire and North American F-86K fighters. The importance of this experience was evident in the G.91 (1956), selected to fulfill the light attack role by Italy and Germany, where it was built by Dornier. Possessing limited combat value but delightful handling, the G.91 equipped the Frecce Tricolori display team for 13 years. Its variants comprised the two-seat advanced trainer (G.91T, 1960) and the twin-engined Y attack aircraft (1966).

In 1961, Fiat became the main contractor for the Italian Group in the F-104G program, leading five other Italian participants and coordinating with the West Group in Belgium. Fiat took over even greater responsibilities for the F-104S, launched in 1966 and built until 1979. Conceived in 1962 as a vertical/short-takeoff-and-landing tactical transport, the G.222 flew in conventional form in 1970.

In 1969, Fiat became the Italian industrial partner for the nascent Tornado program, but a few months later Fiat merged its aircraft business with Aerfer and Salmoiraghi to form Aeritalia. In 1976, with the auto market in severe crisis, Fiat withdrew from airframe manufacture, selling its 50 percent share of Aeritalia to IRI-Finmeccanica and concentrating aero engine production in a new Fiat Aviazione (FiatAvio from 1989), which later absorbed the Fiat energy division (1987), the BPD space propulsion activities (1994), and Alfa Romeo Avio (1997).

Gregory Alegi

See also

Aeritalia; Ansaldo; Italian Air Force; Italian Aircraft Development; Lockheed F-104 "Starfighter"; Panavia Tornado; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II)

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Field Manual 100-20 (U.S. Army)

Helped define the proper role of airpower in war, a thorny subject within the U.S. Army prior to World War II. Ground officers tended to see the air weapon as a useful, perhaps even necessary, tool that would help them gain their tactical objectives. As a consequence, they insisted on controlling those air assets themselves and, indeed, apportioning them out to various ground commanders for their specific use.

Airmen, by contrast, saw aircraft as an inherently strategic weapon that should be used not only to assist ground operations but also to operate at the strategic level of war as well. They therefore favored a centralized system in which theater air assets would be controlled by a single airman; some assets would be designated for use in strategic air operations and others for tactical cooperation. Existing U.S. Army doctrine, not surprisingly, endorsed the ground view.

The North Africa campaign of 1942–1943 forced a reevaluation. Airpower was not viewed as having been overly responsive or flexible in that campaign. Six months of combat experience, reinforced by contact with British forces that had been at war far longer, dictated a change. The War Department therefore directed that a new doctrine manual be written. The task was given to two airmen and an armor officer, and their product was War Department Field Manual (FM) 100-20, *Command and Employment of Air Power,* published in July 1943.

FM 100-20 began by stating in bold capital letters: "LAND POWER AND AIR POWER ARE CO-EQUAL AND INTERDEPENDENT FORCES; NEITHER IS AN AUXILIARY OF THE OTHER." The manual then stated that flexibility was airpower's greatest asset, and that asset could only be ensured if airpower was centralized and controlled by the air commander. It posited a command arrangement in which the theater commander exercised authority through two component commanders—one for air forces and one for ground forces. The manual warned that the theater commander should not attach air units to ground commanders except in rare cases where units were geographically isolated. Thus, in the first two pages the two top issues of airpower's basic function, as well as who should control it, were addressed and decided in terms that favored airmen.

Perhaps in an attempt to soften the message, the manual then stated that because air and ground operations were interdependent, joint planning and joint training were absolutely essential to success.

The basic tasks of airpower were listed as the destruction of hostile air forces; denial of establishing hostile airbases; operations against land and sea forces; offensive air operations against an enemy's sources of military and economic strength; service in joint task forces, and in conjunction with or in lieu of naval forces.

Strategic air operations were described in the manual as those that aimed to defeat the enemy nation by striking at its "vital centers." Strategic air forces would be controlled by an airman, but the selection of their objectives would be the responsibility of the theater commander. Thus, in certain circumstances, strategic air forces could be used to achieve tactical objectives.

When discussing the role of tactical air forces, the manual listed three functions in order of priority. The first priority was to gain and maintain air superiority over the theater. This was an intensive and continuous process that required offensive actions against the enemy's air force and aviation infrastructure as well as strong air defenses. The second priority was to isolate the battlefield by preventing the movement of hostile troops and supplies—"air interdiction" in today's parlance. The third priority was the destruction of selected targets in the battle area, generally in the immediate front of friendly ground forces. Today this would be termed "close air support."

Air and ground officers alike saw FM 100-20 as a "declaration of independence" by the air arm. Although the manual was approved by the Army hierarchy, including the Chief of Staff, General George C. Marshall, most ground officers thought it went too far. They feared it would result in a decrease in the amount of tactical air assets committed to the ground battle. Conversely, many airmen felt the manual did not go far enough and objected to the statement of interdependency: Strategic air operations, they believed, could be conducted independently, and simultaneously, with tactical air operations. In addition, some airmen rejected the designation of strategic and tactical air forces. They thought airpower was indivisible, and that to divide it arbitrarily into separate forces would result in a loss of flexibility—airpower's greatest attribute.

Subsequent events would give fodder to both points of view. Despite its controversial nature, FM 100-20 remained official Army doctrine for the remainder of the war. Seen in the broader context, FM 100-20 was a stepping-stone on the path to an independent United States Air Force, which was created in 1947.

Phillip S. Meilinger

See also

Air Interdiction; Close Air Support; North African Campaign; Tactical Air Warfare; U.S. Air Force Doctrine

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A captured Fieseler Storch, perhaps the most efficient liaison plane of World War II. It was in a Storch that Otto Skorzeny flew Mussolini to "freedom" in 1943. (U.S. Air Force)

Fieseler Fi 156 Storch

German liaison plane. Following its failure to successfully compete for the Stuka contract in 1935 (its model 98 prototype having crashed and killed the pilot), the Fieseler factory moved to compete aggressively to win a new contract, this time for a light liaison aircraft. Using experience acquired with the F-97 four-seater, an engineering team designed the Storch (Stork) in six months and flew the first of three prototypes in 1936.

One of the pre-series aircraft made a stunning impression at the Dübendorf meeting in Switzerland in 1937 by taking off short and hovering in a headwind. Various models from reconnaissance to air ambulance were ordered, and early versions saw service in the Spanish civil war. Almost 2,600 were built until the end of World War II and served on all German fronts. In the meantime, two prototypes of a bigger version, the Fi 256, were assembled by Morane-Saulnier in occupied France, but they were abandoned. The latter company used the experience to assemble its MS 500 Criquet, a French version of the Storch, after the war.

The Fieseler firm gained notoriety through the development of the Fi 103 flying bomb, better known as the V-1.

Guillaume de Syon

See also
V-1 Missile and V-2 Rocket

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Fighter Air Corps, 64th (Soviet Air Force)

The 64th Fighter Air Corps (64 IAK—Isrebitelnyi Aviatsionnyi Korpus) was established in northeastern China on 26 November 1950 and headquartered in Mukden (Shenyang). Its purpose was to control fighter units of the Soviet VVS (Air Forces) sent to assist the North Korean and Chinese forces in the Korean War, by preparing those units to operate the MiG-15 and providing air defense against UN air attacks.

During the war, the units of 64 IAK flew the great majority of communist sorties and scored a disproportionate share of their victories. Initially, 64 IAK consisted of three fighter divisions that began operations on 1 November 1950. In March 1951, these divisions rotated home and were replaced by new units. A second rotation of units occurred during the summer of 1952. This cycling of units allowed more pilots to gain experience in jet combat but also had the effect of depressing experience and skill in the combat zone. The 64 IAK also was assigned the night interception role. It was initially equipped with the La-11, then the MiG-15, along with two antiaircraft artillery divisions, two searchlight regiments, and support units. In 1953, two regiments of naval MiG-15s were added to the night interception task.

According to Soviet sources, units of 64 IAK flew 63,229 sorties (60,450 day, 2,779 night), participated in 1,790 air combats (1,683 day, 107 night), and shot down 1,309 enemy aircraft, including 1,097 by fighter aviation (1,067 day, 30 night), and 212 by antiaircraft artillery. The Soviets lost 13 pilots killed in noncombat accidents and 111 pilots killed in combat, in addition to about 350 aircraft. Even allowing for additional Chinese and North Korean air activity, these figures remain at variance with UN loss and victory claims, suggesting that overclaiming occurred on both sides.

George M. Mellinger

See also

Korean War; Kozhedub, Ivan; Pepelyaev, Evgenii Georgievich; Sutyagin, Nikolai

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Finletter Commission

The Air Policy Commission, established by President Harry Truman in July 1947 with Thomas K. Finletter serving as chair. Its charter was to make an objective inquiry into national aviation policies and problems. After three months of study and the interviewing of 140 witnesses from the military services, industry, and commercial aviation, the commission issued a report, *Survival in the Air Age.* Its main conclusion was that the security of the United States in the nuclear age would rest on airpower and that the Air Force, as well as naval aviation, should be greatly expanded to meet future threats.

Phillip S. Meilinger

See also

Cold War; National Security Act of 1947; Truman, Harry S.

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Finnish Air Force (Early Years)

The Ilmailuvoimat, Finland's air force, is one of the oldest official independent aviation forces in the world. During the revolution in 1917, the Finns saw a chance to break away from the Russian empire and become an independent country. Their war of independence began in December 1917 under General Gustaf Mannerheim. In February 1918, the first of two donated aircraft arrived to assist Finland's White Army. The first aircraft was a Nordiska Aviatik–built Albatros two-seater. It arrived in Kokkola from Sweden on 25 February 1918. The second donated aircraft, a Thulin D, came from Count Eric Von Rosen, a Swedish explorer. His donation, flown by Lieutenant Nils Kindberg, arrived on 4 March 1918. Rosen had painted a blue swastika, his personal good-luck symbol, on the fuselage of the plane. This blue swastika became the Ilmailuvoimat's official insignia, an unfortunate resemblance to Nazi Germany's black swastika. By 10 March 1918, the Ilmailuvoimat was officially formed and given its own commander.

Shortly thereafter, the Ilmailuvoimat acquired a rather motley collection of aircraft, but enough to complete two flying divisions. These aircraft were Thulin Ds, Nodiska-built Albatros B.Is and C.IIIs, several captured Russian Nieuport 10 and 23s, as well as Shchetinin M5, M9, M15, and M16 hydroplanes—a total of 47 aircraft of 19 different types. During World War I, the aircraft were used for reconnaissance and limited bomb-dropping. Recruits went to Germany for training until June 1919, when a French military mission arrived with 12 pilots under the command of Major Raoul Etienne to initiate training at home.

The Finns spent 20 million Swiss francs to purchase 20 Breguet 14 B-2 reconnaissance planes and 12 Georges Levy hydroplanes, but they soon recognized the need for an indigenous aircraft factory. In 1920, the same year as the peace treaty with Russia, the Ilmailuvoimien Lentokonetehdas (Aviation Force Aircraft Factory) was created and concentrated on Hansa Brandenburg W 33 monoplane floatplanes. Floatplanes and hydroplanes predominated during the years between the wars, upon the advice of a British mission that arrived in 1924. Early in the 1920s, the Ilmailuvoimat was also tasked with aerial photographic survey duties, a mission it carries out today.

Wendy Coble

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Finnish Air Force (in Russo-Finnish Wars)

Seeds of tradition were sown in the Ilmailuvoimat (the Finnish Air Force) during the Winter War (30 November 1939–12 March 1940) against the Soviet Union. Finnish air operations hit their stride during the Continuation War, so called because it continued the conflict begun by the Soviets in 1939. The first real combat for the Ilmailuvoimat occurred during the Soviet invasion of Finland. In this war, the Finns scored 190 confirmed kills and more than 100 probables. They achieved a 16:1 ratio with the Soviets—in aerial combat, the Finns shot down 16 Soviets for every one of theirs the Soviets downed.

The small and ill-equipped Ilmailuvoimat followed certain principals to ensure success. First, by concentrating its fighter power and using the element of surprise, it achieved temporary air superiority. Second, it flew in small, flexible formations. Next, it demanded that its pilots be skilled in aerobatics and combat maneuvers. Finally, Finnish pilots were continuously trained until they were masters in shooting accuracy.

Although Finland did not share the Nazi political ideology, it still formed an alliance with Germany to defend itself against the Soviet Union. When Hitler invaded the Soviet Union on 22 June 1941, Finland went to war. The air force began the Continuation War with 120 fighters (Brewsters, Fiats, Curtisses, Morane-Saulniers, and Hurricanes) and 58 mostly obsolete reconnaissance planes.

Initially, the Finns were quite successful against the Soviets, achieving a 32:1 exchange ratio. As the war went on, the Finnish forces became less effective despite the acquisition of limited numbers of German Messerschmitt Bf 109Gs and Junkers Ju 88s.

The Battle of the Gulf of Finland is the best example of air operations during the war. The Finnish fighter pilots were successful, attaining an average exchange ratio of 25:1. Their strategy of focusing on aerial combat made the difference; raids on Soviet air bases were not worth the risk. The Soviets had no shortage of aircraft but lacked experienced pilots. By focusing on eliminating these trained Soviet pilots, the Finns achieved air superiority.

The Soviets did not wish to spend what was necessary to defeat the Finns militarily, so on 4 September 1944 a peace agreement was signed. The Ilmailuvoimat again finished a war with more fighters than it started with. Finland ended with the largest proportion of aces in the world in relation to population. Most of the Finn aces survived the war.

Scott R. DiMarco

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Finnish Air Force (Recent History)

The heroism that the Finnish Air Force exhibited during the Winter War with the Soviet Union in 1939–1940 was displayed again in the Continuation War, which it fought from 22 June 1941 to 4 September 1944, when once again overwhelming Soviet numbers forced a Finnish surrender.

After World War II, activity of the Finnish Air Force was greatly restricted, being limited in size to 60 aircraft, usually of Soviet manufacture. Over time, it began to reassert its independence from the Soviet Union and built up a modern air force, initially supplementing its MiG-21 aircraft with Swedish Saab J-35 Draken fighters. A major modernization program began in 1995 with the acquisition of 64 McDonnell Douglas (Boeing) F/A 18 Hornets. The Finnish squadrons are also equipped with flights of the British Aerospace "Hawk," which is used as an economical proficiency trainer and light fighter.

The Finnish Air Force is noted today for its high standards of training and maintenance.

Walter J. Boyne

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First Aero Squadron

Founded prior to World War I at a time when the United States could have remained competitive in military aviation with Europe. Instead, Europe went to war and the United States involved itself in border problems with Mexico.

As a rehearsal for later U.S. intervention in World War I, the fighting in Mexico proved ineffective. The heat was the real enemy. It melted the glue binding the laminated wood propellers and kept the 1st Aero Squadron's few Curtiss aircraft grounded most of the time. When the United States entered World War I in 1917, however, the pilots of the 1st Aero Squadron provided a personnel nucleus, which went on to command positions in the United States Air Service.

James Streckfuss

First Marine Air Wing

U.S. Marine close air support force during the Korean War. By the end of World War II, the Marines had almost perfected the art of close air support by fighters. As the Cold War heated up, the Marines became specialists in rapid deployment. The era of close support from the Navy's battleships and heavy cruisers was drawing to a close. The Marines now had to provide close air support from their own Marine aircraft.

When the Korean War started on 25 June 1950, all of the Marine forces were stateside. President Harry Truman's call to arms was answered by the 1st Marine Division. Forming up with the division was a group of aviators that flew the Chance-Vought F4U Corsair, the Douglas AD Skyraider, and a host of other support types. This became the 1st Marine Air Wing, and its only objective was to support the ground troops without regard to the cost. At the time of their entry into combat, their commanding officer was Major General Field Harris.

The 1st Marine Air Wing's entry into the war coincided with its counterpart, the 1st Marine Division, in early September 1950. Both were in place to support the successful amphibious landing at Inchon that cut the supply lines of the North Korean army between the Pusan perimeter and the North. It proved to be the most decisive military ground action of the war.

The 1st Marine Air Wing flew Corsairs as well as the night-fighter version (the F4U-5N) along with the heavy-hauling Skyraiders. During the Chosin Reservoir action, VMF-311 became the first Marine squadron in history to fly jets in combat, using the Grumman F9F Panther. The Grumman F7F-3N Tigercat was assigned night interdiction duties.

The 1st Marine Air Wing was tasked with dangerous low-level close air support missions against a myriad of small arms and heavy antiaircraft fire. Protecting the Chosin Reservoir retreat was perhaps the most difficult assignment because of severe weather conditions. Soon after the war ended on 27 July 1953, the 1st Marine Air Wing received one of the highest awards that could be earned in combat during this period, the Presidential Unit Citation. This was signed by South Korean President Syngman Rhee. The most significant statistic in this citation was that between 27 February 1951 and 11 June 1953 the 1st Marine Air Wing flew more than 80,000 combat sorties.

Warren E. Thompson

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Fleet Air Arm

Aerial striking force of the British Royal Navy (RN). Early in the twentieth century, RN aviators duplicated Eugene Ely's feat of launching aircraft from ships. In 1911, a successful launch occurred from the battleship HMS *Africa.* Subsequently, the period after 1914 saw further development of RN seaplane tenders and attempts at carrier conversions. The RN commissioned its first aircraft carrier, HMS *Argus,* in 1918.

The Royal Naval Air Service of World War I became the Fleet Air Arm (FAA) in 1924. Initially it remained integral to the Royal Air Force. Consequently, problems concerning personnel and procurement of suitable aircraft hampered the FAA's growth. Adopting the RAF's squadron structure, the FAA possessed only 232 aircraft by 1939, most of them technically obsolescent. That condition changed dramatically under the pressures of war. By mid-1945, the FAA counted more than 1,600 aircraft in 73 squadrons. These aircraft flew from more than 50 fleet, light, and escort carriers.

The FAA's aircraft included several well-received U.S. types: the Grumman F4F Wildcat (Martlet in RN service) and F6F Hellcat as well as the TBF Avenger; the FAA also operated the Chance-Vought F4U Corsair.

British-made aircraft also supplied the FAA. The venerable Fairey Swordfish biplane torpedo-bomber (the "Stringbag"), though obsolete, was remarkably versatile and long-lived. Fairey also supplied the Barracuda torpedo-bomber and the Firefly reconnaissance-fighter. Hawker contributed the Sea Hurricane (the RN's first single-seat monoplane carrier-borne fighter). Supermarine modified its immortal Spitfire as the Seafire, and Blackburn Aircraft supplied Skua dive-bombers and the Firebrand fighter/torpedo-strike aircraft. Though making a significant contribution to the Allied victory, the FAA suffered severe reductions after 1945 as the Royal Navy was reduced to a peacetime establishment.

D. R. Dorondo

See also

Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Fletcher, Frank Jack (1885–1973)

Admiral and carrier task force commander. Born in Marshalltown, Iowa, on 30 October 1882, Fletcher attended the Naval Academy. He won the Medal of Honor at Veracruz in 1914 and the Navy Cross as a destroyer commander during World War I. Never an aviator, Fletcher followed a typical surface career, was promoted to rear admiral in 1939, and had command of Cruiser Division Six when World War II began.

Fletcher's task force participated in air strikes on Japanese forces in the Gilbert and Marshall Islands and New Guinea. At the Battle of the Coral Sea (May 1942), Fletcher's planes turned back the Japanese in the first battle fought solely between carriers and embarked aircraft.

Fletcher next deployed his carriers to defend Midway Island. Though Admiral Raymond Spruance took command when Fletcher's flagship was battered, the carriers Fletcher led into that battle scored a major victory over Admiral Chuichi Nagumo, who lost four carriers to Fletcher's one. Fletcher was rewarded by immediate promotion to vice admiral.

He was also victorious in the Eastern Solomons (August 1942), but charges of undue caution began to affect Fletcher's reputation, especially after he withdrew his vulnerable carriers from Guadalcanal, leaving the expeditionary force without adequate air support. After his flagship was torpedoed, Fletcher was relieved pending recuperation.

Fletcher returned to command the North Pacific Area, but he never again commanded carriers at sea. He later chaired the Navy's General Board, was promoted to admiral, and retired in 1947. Fletcher died in Bethesda, Maryland, on 25 April 1973.

Michael S. Casey

See also
Coral Sea, Battle of the; Eastern Solomons, Battle of; Guadalcanal; Halsey, William F.; Midway, Battle of; Nagumo, Chuichi; Spruance, Raymond A.

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Flight Refuelling Ltd.

Pioneered the use of aerial refueling. Based on his own experiments beginning in 1932, British pilot Sir Alan Cobham (1894–1973) formed Flight Refuelling Ltd. in 1934, with initial support from Imperial Airways, to develop technologies for air-to-air refueling of aircraft. The company's hose refueling techniques were deemed essential to development of long-distance air routes and were tested on Imperial flying boats in 1938–1939.

These tests included transatlantic flights and achieved refueling rates of 120 U.S. gallons per minute. During the war, Flight Refuelling personnel assisted the U.S. Army Air Forces in developing aerial refueling techniques. Further trials in 1946–1948 employed wartime bomber aircraft modified as tankers to test the use of radar in bringing the tanker and receiver aircraft together on various routes and weather conditions.

The first round-the-world nonstop flight (February-March 1949 by the B-50 bomber *Lucky Lady II*) employed methods pioneered by Flight Refuelling. The company expanded and diversified its operations after the 1950s and became central to Royal Air Force capabilities in the Falklands War (1982) and the Gulf War (1991), in which distance flights were essential. By 2000, Flight Refuelling Ltd. had 1,300 employees in three divisions: military systems (drones, air-to-air refueling, weapons release, and drop tanks), FR Digital Systems (primarily air traffic control systems), and FR Hi-Temp (aircraft fuel systems and equipment). It is part of the Cobham PLC group of companies.

Christopher H. Sterling

See also
Aerial Refueling

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Flying Boats

Flying boats were important to early aviation because water was widespread, whereas land airports took money and time to build. Henri Fabre was the first person to successfully take off from and land an aircraft on water—in 1910 near Marseilles.

Just a year later, Glenn Curtiss interested the U.S. Navy in the flying boat's potential. Curtiss developed the boat-shaped hull with a break, or "step," on its bottom to ease takeoffs, an innovation that was soon featured on all flying boats.

The first airliners were Benoist flying boats of the St. Petersburg–Tampa Airboat line in early 1914. A Curtiss H-12 flying boat became the first American aircraft used in combat in mid-1917. A Navy Curtiss NC-4 flying boat was the first aircraft to cross the Atlantic just two years later.

In the 1930s, a few dozen large flying boats opened up world airline service for Imperial and Pan American, including the first transpacific service in 1935 and transatlantic routes by 1939. Though nearly 8,000 flying boats were built (chiefly by Britain, Japan, and the United States) for patrol, rescue, and antisubmarine use during World War II, construction of more efficient long-distance aircraft and airports to serve them spelled the eventual end of the flying boat. Most airline use ended in the 1940s; naval flying boats were phased out by the mid-1960s, replaced by more reliable and economic land- or carrier-based aircraft. Only a handful of patrol and fire-fighting flying boats remain in service.

Christopher H. Sterling

See also

Balbo, Italo; Beriev Aircraft; Blohm and Voss Aircraft; Consolidated PBY Catalina; Fleet Air Arm; Saro Aircraft; Short Sunderland; U.S. Coast Guard Aviation

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Focke-Wulf Aircraft

German aircraft manufacturer; originated in the work of Heinrich Focke (1890–1979) He designed light aircraft together with his friend and colleague, Georg Wulf, including the Ente (Duck), which had canard-configured stabilizers and was intended for use as a trainer. Flight-testing it in 1927, however, Wulf crashed the machine and lost his life. The company kept the name of the joint collaboration and continued to produce light aircraft while competing for civilian contracts.

Focke functioned as head of the company until 1931, when he was eased out by financial backers, though he remained a member of the board of directors. A new technical director, Kurt Tank, was hired to oversee development of most factory prototypes. Focke, meanwhile, devoted time to pet projects, in particular helicopter experimentation. The Focke Achgelis factory turned out several prototype helicopters, including the Fa 61, test-flown by Hanna Reitsch before an audience in the Deutschland-Halle.

Meanwhile, Kurt Tank's key role in the development of Focke-Wulf machines grew considerably. The factory began producing a series of prototypes while manufacturing aircraft for other companies due to the dearth of production capacity in the mid-1930s. Some Focke-Wulf machines were nonetheless produced successfully and included the Fw 44 Stieglitz, a two-seat trainer, and the Fw 58 Weihe.

Tank pushed for the production of prototypes in response to various army contracts. These included "unlucky" entries submitted in response to Luftwaffe requirements. Among them were the Fw 157, a single-engine fighter, and the Fw 187, a twin-engine fighter; they were bested by the Messerschmitt Bf 109 and Bf 110 respectively.

Among the successful developments of the company was the Fw 200 Condor, a civilian long-range transport that also saw service in the Luftwaffe as a long-range patrol. The FW 189 model, a twin-engine plane, was used principally on the Russian front. By the time production ceased in 1944, more than 800 machines had been built, many in Czech and French subsidiary factories.

The Fw 190 is probably the best-known production of the factory. It went through a series of versions, with new designs bearing the designation "Ta" as of 1943. Thus, later versions of the Fw 190 (like the Ta 152) bore that designation. Tank developed a twin-engine fighter out of wood intended for the night-fighter program, but it lost out to the Heinkel 219 "Uhu" (Owl). A series of paper designs followed, which never saw the light of day. However, some may have influenced early jet designs, and one, the Ta 183, served as a base for the construction of the Argentine Pulqui II jet prototype in 1950.

After World War II, the Focke-Wulf firm, like all German manufacturers, was forbidden from producing aircraft for a period of 10 years. Its management focused on license production of the Piaggio 149 trainer. Later productions followed, but by then Focke-Wulf was part of a growing German aerospace concern that first included VFW-Fokker, then MBB, and eventually became part of Daimler Aerospace, itself now part of the European consortium EADS.

Guillaume de Syon

See also

Focke-Wulf Fw 190; Focke-Wulf Fw 200 Condor; Heinkel Aircraft; Messerschmitt

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Focke-Wulf Fw 190

Designed by Kurt Tank, the Focke-Wulf 190 was the epitome of deadly elegance. It was engineered for mass production, employing subassemblies from many widely dispersed factories. Multiple panels and excellent cowl design afforded quick access and easy maintenance.

A BMW radial engine provided 1,700 hp at takeoff and 1,440 at 19,000 feet. At the pilot's choice, movement of the throttle controlled an ingenious apparatus that automatically adjusted supercharger blower, propeller pitch, and fuel flow and mixture. A semireclining seat facilitated high-G maneuvering. Controls were light to the touch and beautifully harmonized. Visibility in flight was outstanding.

One of the most popular and efficient fighters of the German Luftwaffe, the Focke-Wulf Fw 190 was extremely effective in close air support work. (U.S. Air Force)

In July 1941, the Fw 190 entered combat, inflicting heavy losses on its Spitfire VB opponents. The sleek machine also became a Luftwaffe workhorse on the Russian front and in the Mediterranean theater. In the course of the war, 20,051 Fw 190s were manufactured.

The Fw 190 was fast at 408 mph at 20,600 feet with methanol water boost. Acceleration was swift and speed in the dive fast. The Fw 190 excelled in roll rate and sharp aileron turns. Heavily armed, it eventually featured two heavy 13mm machine guns and four 20mm cannons. A stable weapons platform, the Fw 190 was a very effective fighter-bomber. Rugged and well protected with armor, it carried a substantial payload. Of all the Fw 190s constructed, 6,634 were especially built for the ground support role.

The Fw 190 was not without flaws. High wing loading led to abrupt stalls and inverted spins, discouraging tight turns. Radius of action, even with two external fuel tanks, remained less than 500 miles. Best performance was obtained from 18,000 to 23,000 feet. Above 25,000 feet performance deteriorated sharply, a shortcoming that proved fatal against the P-47 Thunderbolt and P-51 Mustang. Nonetheless, the Focke-Wulf 190 was a versatile warplane and a formidable adversary.

Sherwood S. Cordier

See also

Focke-Wulf Aircraft; Tank, Kurt

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Focke-Wulf Fw 200 Condor

Aircraft based on a feasibility study ordered in 1936 by Lufthansa for a plane capable of crossing the Atlantic; first flew on 27 July 1937. Designed to carry 26 passengers and four crewmembers, this cantilevered low-wing four-engine plane first proved its capacity on a series of long-distance flights for publicity. The longest was a 48-hour flight from Berlin to Tokyo. (The plane crash-landed in Manila Bay on the return leg due to pilot error.) The aircraft was used mostly on European medium-range routes. Sixteen civilian Condors were completed by September 1939, and several more were under construction.

Meanwhile, the Luftwaffe was having trouble defining its long-range aircraft needs. The Junkers Ju 89 and Dornier Do 19 aircraft were canceled, and the Heinkel He 177 project was delayed. By October 1939, 12 civilian Condors (six of which were initially scheduled for delivery to Japan) had been taken over by the Luftwaffe for training in long-range sea reconnaissance. Focke-Wulf received an order for the development of a military version, the Fw 200C series, of which 243 were produced until the closing of production in 1943. The C-4, which was built in the largest numbers, sported additional machine guns and a bomb/torpedo bay. Its primary mission in the Luftwaffe became long-range reconnaissance and the spotting of Allied convoys in the Atlantic. Positions were then relayed to submarines and an attack coordinated. The Condor also saw service on the Eastern Front, even bringing supplies to encircled troops in Stalingrad. A few specially modified versions were also used as VIP transports (a V3 S-9 version replaced a Ju 52 as Hitler's personal transport).

Two civilian Condors survived World War II and were used in Brazil but were written off by 1947. A few military machines flew in Spain, Denmark, and with the Royal Air Force, but the lack of spare parts quickly ended their careers.

Guillaume de Syon

See also
Focke-Wulf Aircraft

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Fokker Aircraft (Early Years, World War I)

Aviation pioneer Anthony Fokker (1890–1939) emigrated from Holland to Germany in the years before World War I to further his interest in aircraft. With financial help from his wealthy father, he began experimenting in the design of his own aircraft. He soon taught himself to fly and established a factory and flying school at Schwerin, outside Berlin.

After having supplied a moderate number of conventional aircraft, Fokker's fortunes improved during the war, in 1915. Roland Garros's French aircraft used a wedge deflector on the propeller to permit firing through it; one had been captured, and Fokker was tasked to emulate the installation. Instead, Fokker's engineers developed one of the first working interrupter gears, a synchronizing mechanism, and installed it on one of his monoplanes. Acceptance of the aircraft and gun led to deployment of the first true fighter plane, the Fokker E.I "Eindecker" (literally "single wing," i.e., monoplane).

The "Fokker scourge"—the period when the German fighter wreaked havoc on its French and British opponents—began with the introduction of the E.I. The most numerous of the Fokker Eindecker designs was the E.III. Powered by the Oberursel 100-hp rotary engine, lateral control was by wing-warping, and firepower came in the form of a LMG 108 (Spandau) gun synchronized to fire through the propeller. Between 120 and 150 examples of the type were built.

Operationally, the early Fokker was deployed in ones and twos to the *feldflieger-abteilungen* (battalions) until several were grouped together in *staffeln* (squadrons) at Sivry and Vaux. In the hands of pilots like Max Immelmann and Oswald Boelcke, the Fokker was a powerful weapon, but the Nieuport 11 and the de Havilland D.H. 2 soon surpassed it. By autumn it was disappearing from the force in favor of the Albatros and Halberstädt.

Billed as the first true fighter plane, the Fokker Eindecker was equipped with a LMG 108 (Spandau) gun synchronized to fire through the propeller. (Walter J. Boyne)

Considered by many to be the best fighter of World War I, the Fokker D.VII stands behind a row of extremely well-equipped German pilots. (Walter J. Boyne)

Fokker's standing slid for a while after rival designs passed by the Eindecker in the summer of 1916. He recovered his position with the Dr.I "Dreidecker" (triplane). Hailed as one of the most maneuverable dogfighters ever, the triplane achieved immortality in the hands of aces like Werner Voss and Manfred von Richthofen.

Rotary powered and equipped with two LMG 08/15 (Spandau) guns, the triplane was highly maneuverable and climbed quickly. The first two examples were delivered to Jagdgeschwader I (von Richthofen's Flying Circus) in August 1917 as personal gifts for Richthofen and Voss, the two leading German aces.

Early wing failures caused the type to be withdrawn temporarily until the shoddy workmanship at the root of the problem was solved. This delay resulted in a total of only about 320 aircraft being produced. Triplanes returned to the front in 1918 and served as the principal equipment of the elite fighter groups during the great German offensive that spring. By summer, the triplane began to be replaced by the new Fokker D.VII, although it continued in use for a while longer.

In January 1918, the Luftstreitkräfte (Air Service) decided to hold an open competition for the next single-seat fighter. The clear winner was a single-bay biplane with thick cantilevered wings powered by the six-cylinder Mercedes engine. It would become the Fokker D.VII, generally regarded as the best single-seat fighter of World War I.

In May, early examples of the new fighter arrived at the front. Impressive as the first version was, the D.VII was even better when it was coupled with the new BMW high-compression 185-hp engine, which added 3,000–5,000 feet to its ceiling and improved its speed.

The D.VII reequipped most of the *jagdstaffeln* (fighter squadrons) in German service, revitalizing the fighter force despite the shortage of fuel that kept it grounded much of the time. In September, it inflicted a record number of casualties on the British. The reputation of the D.VII was such that it was specifically named for surrender in the Armistice agreement.

Following the war, Fokker returned to Holland, smuggling most of his inventory with him, and was able to remain in aviation.

James Streckfuss

See also

Garros, Roland; Richthofen, Manfred von

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Fokker Aircraft (Post–World War I)

After World War I, Anthony Fokker (1890–1939) moved his aviation concern from Germany to the Netherlands to begin again in July 1919 as a Dutch company, based at the former Dutch Naval Air Service base in Veere, Zeeland, until 1924 and then at Amsterdam. Initially, company output was divided among fighter aircraft for several nations and early airliners. The Dutch airline KLM, founded the same year, became an important purchaser of Fokker airplanes. The first U.S. transcontinental flight was accomplished with a Fokker F.IV (T-2 to the Army Air Service) in May 1922. Two years later, a KLM Fokker F.VII made a multistop 8,000-mile flight from Amsterdam to Batavia (now Jakarta) in the Dutch East Indies (now Indonesia). By this point, Fokker transports used two or three engines, wooden construction, and thick cantilevered wings. Increasingly large and complex airliners would range from the single-engine F.I to the four-engine F.XXXVI by 1939.

During the 1930s, a U.S. arm of the Fokker firm built civil aircraft as well. Military output ranged from the biplane C series of the 1920s (of which the C.V family served into early World War II) to the D.XXIII of 1939, a low-wing monoplane with fixed landing gear, and the twin-engine G.1 heavy fighter.

But Fokker had fallen behind in airplane technology, sticking with wood when others moved to all-metal construction. Germany occupied the Fokker facilities during World War II (just months after the pioneer aviator's death) and compelled manufacture of German aircraft, hindered to some degree by the passive resistance of Dutch workers. A new factory was developed at the Schipol airport outside Amsterdam by 1951.

The company manufactured a variety of trainers (including the S.14, the first jet trainer designed as such and the first Fokker jet) and in 1955 first flew the F.27 "Friendship" twin-engine regional airliner that would remain in production for many years and became a great success worldwide. The F.28 "Fellowship" twin-jet transport followed in 1967 and was improved and stretched to become the F.100 jet transport, which first flew in 1986. With increasing consolidation, however, the limited line of Fokker products could not survive marketplace competition from industry giants, and after several attempts to save it, the company declared bankruptcy in late 1996 and closed down production shortly thereafter.

Christopher H. Sterling

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Young Anthony Fokker had much to smile about. A great pilot and salesman, he was able to use the talents of good engineers to create high-performing aircraft. (Walter J. Boyne Collection)

Folland, Henry Phillip (1889–1954)

Important early British aircraft designer, primarily of fighter and racing aircraft. "HPF" (as Folland was widely known) had a generally conservative approach, remaining throughout most of his career strongly antimonoplane, anti–metal structure, and anti–variable-pitch prop.

He came into his own as the chief designer during World War I at the Royal Aircraft Factory, where he was primarily responsible for a fighter series culminating in the classic SE.5a, widely regarded as the supreme fighter of the war. Folland's glory days peaked in the 1920s with his series of racing and fast fighter biplanes. His 1921 Bamel won its first races, the beginning of a three-year stretch of success, just as Folland moved on to Gloucestershire (later Gloster) Aircraft as chief designer and engineer. There he turned to floatplanes for the Schneider Trophy races: the ill-fated Gloster II and III-A, which came in second in the 1925 race; the handsome Gloster IV for 1927; and Folland's first monoplane, the Gloster VI, which placed in 1929. He also designed the Gloster Grebe, the water-cooled Grebe-like Gorcock, the Gauntlet, and the Gladiator (1934).

Folland's last design was a fighter built to specification F.5/34, but as an air-cooled design in a water-cooled era it could not compete with the Spitfire and Hurricane. Folland left Gloster after Hawker (Thomas Sopwith) took over the firm and he felt overshadowed by designer Sidney Camm. British Marine Aircraft attracted Folland in May 1937, and the firm was renamed Folland Aircraft with a factory at Hamble near Southampton. It was a subcontractor during World War II and, after the war, for de Havilland and Bristol. Folland retired in 1951.

Christopher H. Sterling

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Fonck, René Paul (1894–1953)

The Allies' "ace of aces" during World War I. Going to war at its start, Frenchman René Fonck managed a transfer to pilot training in February 1915. Completing flight training in May, he was assigned to Escadrille C 47, flying Caudrons. There he showed the aggression necessary to be a fighter pilot, gaining his first two victories. He transferred to fighters in April 1917, going to Escadrille Spa 103, a part of the famous Stork unit.

With the Storks, Fonck increased his score at lightning speed, having 19 kills before the end of 1917. During 1918, the pace quickened further, and twice Fonck was credited with six victories in a single day, the only pilot to do this during World War I. Though his score eventually reached 75, the highest of any Western Allied pilot, a boastful personality kept Fonck from achieving the beloved status that his predecessor, Georges Guynemer, had earned in the hearts of the French.

James Streckfuss

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Football War

More accurately, the name for this July 1969 conflict between El Salvador and Honduras is the Hundred Hours' War, as fighting ended after four days due to diplomatic efforts by the Organization of American States. But popular disorder stirred up by harassment of opposing fans and players in a qualifying match for the 1970 soccer World Cup provided a vivid name for the conflict. The primary trigger was the harsh expulsion of thousands of Salvadoran small farmers from Honduran borderlands (the precise boundary being disputed in small areas).

Densely populated El Salvador was reputed to have the best army in Central America. Geographically fragmented, Honduras reputedly had the best air force (the Fuerza Aerea Hondureña—FAH) in Central America. The FAH would provide the means to neutralize an otherwise stronger opponent. Given the recent success of Israel (in 1967), the Salvadorans hoped to destroy the FAH while its planes were still on the ground.

Honduras had steadily emphasized its military aviation since the 1930s. The lack of road and rail alternatives had also caused the republic to be the headquarters of the famed TACA airlines, which for a decade or more provided commercial service throughout Central America. Politically, air force officers were not subordinate to army generals.

The Chance-Vought F4U Corsair was the standard fighter of the FAH in 1969. North American T-28s also played an offensive role, as did a few North American T-6s and transport aircraft. No dedicated bombers were available to either side.

The Salvadoran strike involved two Douglas C-47 aircraft dropping bombs at the principal FAH base in the capital, Tegucigalpa. The Hondurans, however, had noted war preparations; most aircraft were ready the north. The FAH was able to provide considerable air support to the Honduran army, helping to blunt the Salvadoran invasion on several fronts. The Hondurans struck back at the Salvadoran air base and damaged oil storage facilities at a coastal port. On the third day of combat, an FAH Corsair pilot shot down three Salvadoran fighter aircraft, two Goodyear FG-1D Corsairs and a North American F-51 Mustang.

Airpower enabled less-populated and poorer Honduras to achieve a standoff in a sudden conflict. Many years of development made a difference when a crisis arose.

Gary Kuhn

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Ford Motor Company

Entered aviation during World War I, when its factory produced 3,950 Liberty engines for the war effort. This engine later powered the U.S.-designed NC-4 planes in the first Atlantic crossing and was used in many other historic U.S.

flights of the postwar period. During the war, Ford-built Liberty engines were installed in the U.S.-made, British-designed de Havilland DH-4 bombers.

Henry Ford set out to prove that commercial aviation was practical. In 1924, Ford Motor Company purchased the Stout All-Metal Airplane Company. William Stout had designed an all-metal single-engine monoplane, and it would be from this 2-AT design that the Ford Tri-Motor 4-AT model evolved. Sometimes called the "Tin Goose," it made its first flight on 11 June 1926. The Ford Tri-Motor became the foundation for the passenger airline system in America.

More than 100 airlines flew the 199 Tri-Motors that Ford built. The "Tin Goose" found its way throughout North America, Central America, South America, Europe, Australia, and China. Ford ended Tri-Motor production on 4 June 1933.

It did not take long for people to discover that the 14-passenger airliner had a remarkable ability as a heavy-duty freight carrier. When it came to hauling freight, the Ford Tri-Motor surpassed every other prewar American commercial transport except the Douglas DC-3.

During World War II, Ford Motor Company reentered aviation by building Consolidated B-24 "Liberator" bombers at the famous Willow Run industrial complex.

Henry M. Holden

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Ford, William Wallace (1898–1986)

U.S. Army brigadier general. One of the key figures in the development of modern U.S. Army aviation, Ford was born on 2 October 1898 in Waverly, Virginia. He graduated from West Point in 1920 and joined the field artillery. The experience of observing fire from Air Corps observation planes in the early 1930s reawakened his boyhood interest in flying. He purchased a light aircraft and became an enthusiastic pilot in his spare time.

Ford commanded a battery during the 1940 maneuvers and criticized the Air Corps for its failure to provide timely aerial observation. He wrote an article calling for the field artillery to fly and maintain its own organic light aircraft to serve as air observation posts for the firing batteries. In December 1941, he was selected to organize and command a detachment to test the concept. He subsequently became the first director of the Department of Air Training at the Field Artillery School in Fort Sill, Oklahoma, serving from August 1942 until October 1943. Promoted to full colonel in June 1942, he advanced to brigadier general in August 1944 (both temporary ranks) and subsequently commanded the 87th Infantry Division (Artillery) in combat.

Although Ford held a number of other aviation-related assignments before he retired as a brigadier general in 1954, his wartime service constituted the period of his greatest influence on the organic aviation program. By insisting on high standards and then living up to them himself, Ford ensured that the organic aviation program got off to a solid start in the field artillery. This man came close to being indispensable.

Edgar F. Raines Jr.

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Foss, Joseph J. (1915–)

U.S. Marine colonel and leading fighter ace of World War II. Joseph J. "Joe" Foss was born in South Dakota in 1915. At the age of 25, he hitchhiked to Minneapolis to join the U.S. Marines, then thumbed his way to Florida for flight training.

Foss entered combat as executive officer of Marine Fighter Squadron 121 (VMF-121) when it arrived on Guadalcanal in October 1942. Flying the Grumman F4F Wildcat, he shot down his first Japanese Zero on 13 October. For more than a month, Foss and the other pilots of VMF-121 engaged almost daily in aerial combat against Japanese planes attacking U.S. Marines on the island. Foss was credited with 23 planes shot down during this period.

On January 15, after his squadron was given a brief respite from combat, Foss shot down three more Japanese planes to raise his score to 26, matching the aerial record of Eddie Rickenbacker, who shot down 26 German planes during World War I.

President Franklin Roosevelt presented Foss the Medal of Honor for his skill as a fighter pilot and combat leader. After the war, Foss left the Marine Corps and entered private business. He became a brigadier general in the Air National Guard, a state legislator, governor of South Dakota, commissioner of the fledgling American Football League, and head of the National Rifle Association.

James H. Willbanks

See also
Guadalcanal; Rickenbacker, Edward Vernon

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Foulois, Benjamin D. (1879–1967)

One of America's earliest airpower pioneers and pilots. Benjamin D. "Benny" Foulois was born on 9 December 1879 in Washington, Connecticut. In 1898, he enlisted in the U.S. Army Corps of Engineers. He participated in the campaign in the Philippines and in 1899 transferred to the infantry, where he received his commission as a second lieutenant in 1901.

On 19 June 1908, he graduated from the Army Signal School and was detailed to the Signal Corps's Aeronautical Board, which was conducting airplane and dirigible performance trials. In August, Foulois and two other officers learned to fly Dirigible No. 1.

In 1909, Foulois served on the official board evaluating the Wright Flyer. During the speed qualification tests, he flew with Orville Wright to meet the passenger requirements of their contract. Army leaders selected Foulois and Lieutenant Frank P. Lahm to become their first pilots. In preparation, Foulois was sent to France as America's official delegate to the International Congress of Aeronautics.

Next, Foulois took the Wright Military Flyer and a small group of enlisted men by train to Fort Sam Houston, San Antonio, Texas. Aided by written instructions and letters from the Wright brothers, he taught himself to fly. By September 1910, he had made 61 flights totaling 9 hours. He crashed so much that the worn-out plane had to be retired. It was donated to the Smithsonian Institution on 4 May 1911. Foulois's heroic effort eventually led to the acquisition of $125,000 for additional development and training.

Benny Foulois taught himself to fly in the Wright Military Flyer, then went on to become Chief of the Air Corps in 1931. He died at 85, beloved by all, in 1965. (U.S. Air Force)

In 1911, Foulois designed the first airplane radio receiver. Following tours at the Signal Corps Aviation Schools in San Diego, California, and Galveston, Texas, Foulois became commander of the 1st Aero Squadron stationed at Fort Sill, Oklahoma.

In 1916, he led the squadron during the Punitive Expedition against Pancho Villa in Mexico. Their planes were so poor that they could not fly over the Sierra Madre Mountains to deliver mail and messages to General John Pershing's troops. Afterward, Captain Foulois lobbied for better equipment and more pilots.

In 1917, Foulois went to Washington, D.C., to chair the Army-Navy Technical Aircraft Committee. When the United States entered World War I, he was advanced to the rank of brigadier general and named Chief of the Air Service for the American Expeditionary Force and later Chief, First Army Air Service. Although Foulois and Billy Mitchell, Pershing's brash young airpower visionary, did not get along, Foulois recognized Mitchell's brilliance and allowed him to have operational control of U.S. air forces in Europe.

Following the war, Foulois reverted to his permanent rank of major. By 1927, he had once again become a brigadier general and assistant to the Chief of the U.S. Army Air Corps. He served as chief of the materiel division from June 1929 to June 1930. In 1931, he commanded the highly successful USAAC annual exercises, for which he won the MacKay Trophy.

On 20 December 1931, Major General Foulois became the third USAAC chief, serving during four tumultuous years. The high point came with the creation of General Headquarters Air Force, the offensive arm of Army airpower. The low point came when Foulois misjudged USAAC ability to deliver U.S. airmail. Dozens of mishaps and the death of several pilots during the bitter winter of early 1934 created one of the worst public relations disasters in the history of the U.S. air forces. Under public and congressional pressure, Foulois retired on 31 December 1935.

Foulois remained an influential airpower and Air Force advocate until his death in 1967. His memoirs were published after his death in 1968.

William Head

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France, Battle for (1940)

Airpower played a decisive role in the Battle for France. The Allies had more men, tanks, aircraft, and artillery than Germany. But Germany had a superior doctrine and operational concept and deployed better-trained forces.

On 10 May 1940, most Allied aircraft were in Great Britain or Africa, not in northeastern France. Therefore, Germany enjoyed numerical superiority at the decisive point. German and British aircraft were approximately equal qualitatively. Most French aircraft were obsolete, and squadrons receiving modern equipment in early 1940 had low operational readiness.

The Luftwaffe trained intensively for close air support (CAS). Many personnel had combat experience in Spain and Poland. Luftwaffe headquarters were located with the headquarters of the army units they supported. Air liaison teams attached to Panzer divisions provided CAS within 45–75 minutes of a request. In contrast, the Allies had no specialist CAS aircraft, training, or doctrine. Allied air-ground communications and liaison were very poor. Superior logistics enabled German aircraft to fly more than four sorties a day, whereas French fighters and bombers flew 0.9 and 0.25 sorties a day, respectively.

Germany began with diversionary thrusts into Holland and Belgium that drew Allied forces forward to be cut off by another German thrust through the Ardennes to the English Channel. In three days, the Luftwaffe secured air superiority, annihilating the Belgian and Dutch air forces and destroying 229 French aircraft on the ground.

German airborne troops neutralized Belgium's Eben Emael Fortress and seized Dutch airfields and bridges. Holland surrendered after a rapid German ground advance and a brutal air raid on Rotterdam. Meanwhile, the Luftwaffe shielded German forces in the Ardennes from Allied reconnaissance.

On 13 May, 1,000 sorties of the VIII Fliegerkorps supported the crossing of the Meuse (principally by suppressing French artillery). Airlifted supplies enabled Luftwaffe units at rough forward airfields to follow directly behind advancing ground units and maintain the fighter/CAS umbrella. VIII Fliegerkorps permitted Panzergruppe to advance rapidly and disrupted the French Ninth Army's counterattack on the Panzergruppe Kleist's southern flank. Two flak corps repelled desperate Allied air strikes on the Meuse bridges.

The British sent no more fighters to France after May 15 but mounted several ineffectual raids on the Ruhr that week. When German forces halted on the Channel on May 24, Luftwaffe chief Hermann Goering promised to destroy trapped British forces with airpower. Royal Air Force units based in England then clashed with German aircraft at the limit of their ranges. In nine days, Britain lost 177 aircraft and Germany 280, but the British Expeditionary Force escaped via Dunkirk.

France's position was hopeless, and Germany quickly forced its surrender. However, during May-June 1940 Germany had lost 19 percent of its single-engine fighters, 30 percent of its twin-engine fighters, bombers, and dive-bombers, and 40 percent of its transports. These painful losses exacerbated the Luftwaffe's difficulties in the skies over Britain later that year.

James D. Perry

See also

Dunkirk; German Air Force (Luftwaffe)

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Franco, Francisco (1892–1975)

Born in El Ferrol, Spain, to a middle-class family. Franco went to the Military Academy of Toledo (1907–1910), graduating 251st in a class of 312. He rose rapidly, with consistent promotions for battlefield service, and became brigadier at age 33. A strong Spanish patriot-nationalist, he believed the army was the last line of defense and had the right to intervene in politics to save the fatherland. He was contemptuous of the constitutional monarchy (1876–1923) that had lost the 1898 war and was hostile to the Second Republic (1931–1936).

In 1936, he led other generals in a conspiracy and insurrection that became the Spanish civil war. Hitler supplied Junkers Ju 52/3m transport planes to transport Franco's Moorish troops from Africa to Spain, a decisive event in the war.

Franco's Falangists had support from the German Kondor Legion (about 100 planes) and 70,000 Italian soldiers and airmen. The Republicans had help from the Soviet Union and international volunteers, totaling about 60,000 troops. The war ended in 1939 with defeat of the Second Republic. Franco established an authoritarian regime that lasted until his death in 1975.

In 1939, Spain joined Italy and Germany in the Anti-Comintern Pact, which Franco reaffirmed for five years in 1941. Franco's Spain was repressive, having exiled about 300,000 and imprisoned another 300,000 between 1939 and 1945. Estimates on the number shot vary between 28,000 and 200,000.

In 1946, the United Nations found Franco guilty of conspiring with Mussolini and Hitler to bring on World War II; Franco's Spain became an outcast in the community of nations. By 1955, however, Spain was back in the good graces of the western powers. Its Catholicism won over the Vatican, and its anticommunism won over the United States and its Cold War allies. Toward the end of his life, Franco made provisions for a peaceful transition to a constitutional monarchy in Spain. He died in 1975.

John Barnhill

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FRANTIC (1944)

Code name for unsuccessful Soviet-U.S. strategic bombing operation during World War II. U.S. bombers and their escorts would take off from England and Italy, bomb Germany, and recover at bases in Ukraine. After refueling and rearming, the strike force would depart for their home bases, bombing Germany again en route. The objectives of this shuttle bombing were to attack targets previously untouched due to their location deep in the Reich, divert Luftwaffe defensive assets from the West, and foster Allied cooperation. It was hoped that FRANTIC would lead to similar U.S. air bases in Siberia from which to bomb Japan.

FRANTIC was unsuccessful. Because of constant bickering and delay over targets and procedures, only six shuttle missions were flown. There is no indication that any Luftwaffe units were diverted to defend against them. On the night of 22 June 1944, German bombers attacked the major base at Poltava and destroyed or damaged 73 B-17s, leading to further recriminations and delay. The last mission was flown on 19 September 1944.

Phillip S. Meilinger

See also

Combined Bomber Offensive; Lend-Lease Aircraft

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Franz, Anselm (1900–1994)

German aircraft turbine propulsion pioneer; designer of the first mass-produced turbojet engine and of the first helicopter turboshaft engine. Anselm Franz was born on 21 January 1900 in Schladming, Austria, where he spent his youth. He attended and graduated from Graz Institute of Technology, Austria, in 1924 with a master's degree in mechanical engineering. Much later, in 1940, Franz received his doctor of aeronautical engineering from the Technical University, Berlin.

Anselm Franz joined the Junkers Engine Development Division in 1936. In July 1939, two months before the world's first flight of a gas turbine–powered aircraft, Junkers received a contract for the 109-004 turbojet engine. Because of his experience in turbines, Franz was given full responsibility for design and development. Realizing the need for new engine concepts and practices, he insisted on being separated from the existing piston-engine organizations in order to be free from their traditions and influence.

The results of his efforts was the first successful turbojet engine using an axial compressor, air-cooled turbine blades, automatic control of the exhaust area, and afterburning for increased thrust. Construction of the Jumo 004 engine began in 1939, and the first engine was test-run in October 1940. The first flight of the engine, in a Messerschmitt Me 262 on 18 July 1942, was only 30 months after engine design had commenced. It was a remarkable achievement, especially for a new design.

The Junkers Jumo 109-004B went into production at a static thrust rating of 2,000 pounds and a weight of 1,640 pounds. More than 6,000 engines were produced before the end of World War II. They powered the Messerschmitt Me 262 fighter-bomber, the Arado Ar 234 reconnaissance-bomber, the Junkers Ju 287 bomber, and the Horten Ho IX flying-wing fighter. It was the selected engine for many other planned aircraft in development when the war ended. Many of the examples of the engines were taken for study by the

Anselm Franz designed the Junkers Jumo engine used on the Messerschmitt Me 262 and Arado Ar 234, then went on to a distinguished career in the United States. (Kenneth Collinger)

Allied countries, and Russia copied the design and manufactured a large number with the designation RD-10.

Franz came to the United States and worked for the U.S. Air Force at Wright-Patterson Air Force Base in Dayton, Ohio. From 1946 to 1950, he consulted with U.S. turbojet engine manufacturers and realized that there was a potential for medium-power gas-turbine engines for helicopters, propeller aircraft, ground vehicles, and stationary pumps and generators.

In 1950, with the support of the Air Force, he approached the Avco Corporation and proposed developing medium-power gas-turbine engines in a range to complement their piston aircraft engines being produced in Williamsport, Pennsylvania. After being given full authority and responsibility for development, he gathered a small group of specialists to begin the design. Soon after, the group moved from the Williamsport facility to the newly established Lycoming Division in Stratford, Connecticut. After a major competition with many established turbine engine manufactures, the group was successful in winning an Air Force contract for the T53 turboshaft engine in July 1952.

The T53 was contracted at 600 hp to power the Bell XH-40 helicopter. The YT53-L-1 engine made for Bell delivered 860 hp and powered the YH-40 for its first flight on 22 October 1956. Further engine development resulted in versions of the T53 to 1,700 hp. The subsequent production was more than 20,000 engines for more than 12,000 HU-1/UH-1 "Iroquois"/"Huey" helicopters, formerly designated the H-40.

The T53 was closely followed by the T55 turboshaft engine that produced 2,200 hp in its first production version and has been developed to nearly 5,000 hp for the CH-47 "Chinook" helicopter and other applications. Both the T53 and T55 have been produced in turboprop and marine and industrial versions, powering a variety of applications, including aircraft, boats, hydrofoils, hovercraft, trucks, trains, pumps, compressors, and generators.

Another major achievement of Franz was the PLF1A-2, the world's first high-bypass turbofan engine. The engine, first tested in February 1962, was composed of a T55 engine core and a 40-inch-diameter geared fan stage and produced a static thrust of 4,320 pounds. The PLF1A-2 was developed into the ALF502 and LF507 engines at up to 7,200 pounds/thrust, powering the Canadair CL-600 Challenger business aircraft and the British Aerospace 146 and RJ series Avroliner commuter transports. The original PLF1A-2 engine is in the National Air and Space Museum in Washington, D.C.

During the Gulf War, the United States depended on Lycoming engines in the M1 Abrams tank, as well as the UH-1 Huey and Cobra and CH-47 Chinook helicopters and the LCAC hovercraft. Those Lycoming engines were all designed by Franz.

After he retired in 1968 as vice president of engineering and assistant plant manager, he continued as a consultant to Lycoming for several years. On 18 November 1994, Franz died in Bridgeport, Connecticut.

Kenneth S. Collinge

See also

Arado Ar 234 Blitz; Messerschmitt Me 262

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French Air Doctrine

French air doctrine has roots dating to the earliest years of aviation; it evolved significantly during and between the two world wars.

World War I

Before World War I, the French army recognized the need for some kind of air arm based on ballooning units. Thus, by the time conflict broke out, some 20 dirigibles were on hand to conduct reconnaissance and artillery support missions. Airplanes were also added, though their role remained limited to observation.

At the outbreak of World War I, the French army possessed 162 aircraft, which Aeronautics Commander Edouard Barrès reorganized into observation and bombing groups. The former were also responsible for chasing enemy observation aircraft. This notion of specific missions for different squadrons and aircraft was not unique (Clément Ader had thought of it, too), but its application was unique at the time. Meanwhile, General Louis Hirschauer, who had organized ballooning units before the war, was named chief of the air arm. However, his rank and position did not allow him to initiate any clear reform in how the high command thought of aviation. Indeed, although acknowledged as a valuable tool of observation, the airplane was seen as having little value other than engaging similar machines belonging to the enemy.

Operations over the next three years slowly made the high command aware of the advantages of a specialized air arm. General Joseph Joffre (who led the Marne counteroffensive against the Germans) initiated a reprisal air attack on Karlsruhe only after several Zeppelin attacks on French soil in March 1915. When he began considering the best use of aviation, he remained convinced that it should be used in support of ground operations alone, yet he suggested that there should be three types of squadrons: artillery assistance and photography; reconnaissance and bombing; and fighter engagement. Joffre's retirement in 1916 may have put reforms on hold. Things changed in 1917 when, under the impulse of a new organizational structure put forward by Colonel Charles Duval, aircraft became available in quantity. The French high command, desperate for weaponry that might break the stalemate, started sending aircraft over and beyond enemy lines, but this aggressive campaign cost men and materiel, for no fighter escort had been devised to protect the observation aircraft that were used by the French army over its own trenches. This hard-learned lesson explains why, after World War I, squadrons increased in size and were assigned multiple functions.

Interwar Years

However, the air arm remained subordinated to the army. Marshall Henri Pétain, who had led the French army from the Battle of Verdun onward, would not conceive of a separate air force, either. Despite several studies and memoranda in the early 1920s that called for an autonomous "air army" (sometimes termed "national aviation" to avoid antagonizing ground-forces officers), Pétain remained suspicious. The creation of an air ministry in 1928 to oversee both military and commercial aviation further complicated matters, for it added one more level to the French military system. Pétain would finally allow for the hypothesis of an air force only once a new ministry of defense, in charge of overseeing the three other military ministries (war, navy, army), was allowed to coordinate all operations. Thus, a new Territorial Air Defense came into existence in 1931.

Air thinking had evolved starting in 1928. Instead of an offensive air arm, strategists and politicians conceived of the airplane as a way to fill gaps over the projected Maginot Line, a fortified construction intended to check any German advances. In this realm, there was considerable disagreement between airmen and ground commanders over the future war. Some argued that it would begin with massive air bombardments, whereas others claimed the tank would be used first. Pétain seemed sympathetic to the interpretation of Colonel P. Vauthier, who followed the arguments of air strategy pioneer Giulio Douhet and suggested using the threat of massive air attack in case of enemy threats. Yet Pétain and several others rejected the Douhet notion that the army and navy were defensive arms and the air force, the sword. Thus, when the air force was indeed created and formalized as a separate arm, there remained confusion about its precise functions.

In 1934, Plan I of the air force (which confirmed independence from the army) called for aerial bombing, reconnaissance, and interception missions. However, there was now less rigidity in the definition of each unit's purpose. At the top, aerial regiments were replaced by air fleets, each divided into air groups, each of those split into squadrons. These groups were assigned to cover one of the five aerial regions of France and Algeria. With Germany's announcement that it was creating the Luftwaffe, Plan II was enacted, calling for the establishment of a 1,500-aircraft first line of defense. This would be superseded by two other plans, as well as a modification of the air force's basic structure. In addition, an aerial mobilization plan was put together. However, the World War I notion of bomber units also acting as reconnaissance confused the effective development of an air doctrine.

World War II

Pierre Cot, who acted as air minister during the left-wing Popular Front government of 1936–1938, sought to clarify the French air doctrine by having Plan V emphasize fighters. Yet by the time he left office, there was considerable confusion in what an air force should truly do. This had an important impact on later events and may have even affected

The simple, clean lines of the Deperdussin racer were the key to its high 127 mph speed in 1913. (Walter J. Boyne)

Prime Minister Edouard Dalladier's decision to accept Hitler's demands in Munich in 1938: Not only did the Luftwaffe appear better equipped, but the specificity of missions and machines suggested that the French air force, still missing hundreds of fighters from its projected inventory, might not be able to effectively engage it even in a defensive role. This was, unfortunately, the case when the Luftwaffe attacked in May 1940. Combined with the confusion that reigned among the air force officer corps, the confusion over a proper air doctrine gave Germany a decisive advantage.

Guillaume de Syon

See also
French Air Force

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French Air Force

Although technically in existence in 1914, the French Air Force (Aviation Militaire/Armeé de l'Air) underwent a series of changes in the first two decades of its existence; it did not acquire legal status until passage of the Organization Law of 2 July 1934. Until then, it had a semiautonomous status that nonetheless depended heavily on the wants and needs of the army.

By the time World War I began, the air arm was composed of some 162 aircraft facing off against some 250 German airplanes. By fall 1914, under the management of General Joseph Bares, a new standardization procedure was under way, designed to ensure more efficient use of aircraft for observation, interception, and bombing purposes. Several modifications and reorganizations occurred during the conflict in response to increases in men, machines, and technological progress. By 1918, the air arm had almost 20,000 aircraft, tops in the world; the French navy had another 1,000 hydroplanes and several dirigibles.

With the end of World War I hostilities, the air arm now required a permanent structure, which took four years to get approved. New training methods and new squadron structures appeared, designed to streamline the use of the 2,600 aircraft in 186 squadrons in operation by 1926. Still, the aeronautical structure remained fairly complicated, prompting calls for the creation of an air ministry that would manage navy and army air branches. In 1928 such a ministry appeared, headed first by Laurent Eynac. This was the initial step of a five-year effort toward the creation of a general air staff in 1933 and the confirmation of the French air force as its own independent air arm a year later.

Consequently, a new structure appeared, consisting of five aeronautical regions (four in France, one in Algeria). Further modifications followed, few of which took into account the number of aircraft needed in response to the growing threat of the German Luftwaffe.

The air force saw service in the 1920s in the so-called Pacification War in Morocco (also known as the Rif War), and orders were placed with both French and foreign manufacturers for new fighters and bombers. By August 1939, the air force had more than 700 fighters, some 440 bombers, and 400 reconnaissance aircraft. Its budget had steadily been increased, doubling, in fact, between 1937 and 1939.

This was insufficient to hold off the German Luftwaffe and Wehrmacht, which brought France to its knees in six weeks. On 15 June 1940, an armistice was declared, with much of the air force now under control of the Vichy government. A small group of Free French Air Force staff was based in England. This latter force would merge with the French air units stationed in North Africa in 1942 and be involved in various air operations, from fighter escort to bombers and reconnaissance. In addition, some French pilots were incorporated into Soviet units.

French efforts included 67,000 air missions and about 600 air victories, of which only 277 can be officially confirmed. The French air force suffered the heavy toll of 557 losses.

Nonetheless, the French air force, through its efforts, was among the first organizations to be reformed in France's Fourth Republic (1944–1958). With the aeronautical industry almost nonexistent, the air force faced considerable challenges. Not only was its role in future defense planning ill-defined, but the serious economic crisis that affected France also prevented effective modernization. Consequently, the early role military commanders carved out for themselves was that of guardians of the declining French empire, as they sought to stave off rebellions in Indochina and then in Algeria.

The French air force was also involved in the 1956 Suez Crisis, committing F-84s and Noratlas transports to the joint British-French-Israeli force that won the air battle during the campaign.

With the beginning of the Fifth Republic and constitutional democracy in 1958, France's new president, General Charles de Gaulle, made several changes to the status of the air force. The functions of secretaries of state for an arm were abolished, as were the posts of deputy ministers, in favor of greater power to the armed forces minister and the Chief of Staff of each arm. President de Gaulle also called for the development of a French atomic bomb.

With the concept of a triad in mind (sea-, air-, and land-based nuclear weapons), the air force established in 1964 a nuclear section known as the Strategic Forces Command, which oversaw all elements of the triad. First equipped with modified SO-4050 "Vautour" bombers, it soon received supersonic Mirage IV aircraft intended to act as a stopgap until missiles could be produced. The Mirage IV remained in service, in modernized form, until the 1990s, its intended targets in the Soviet Union to be reached by aerial refueling with Boeing KC-135s. French technological and political independence still required, paradoxically, a nudge from a product of the U.S. military-industrial complex.

A review of the French air force's structure in the mid-1960s kept the four aerial regions in existence but called for base commanders to have greater operational autonomy and responsibility. By then, the air force included some 104,000 men and more than 2,300 aircraft, 900 of which were considered front-line machines. With France's exit from NATO's integrated command in 1966, however, the air force's mission changed. Now it would place greater emphasis on the preservation of French interests in the former colonies and participation in various air operations, from interdiction of Libyan incursions into Chad in 1984 to Operation DESERT STORM in 1991.

In the 1950s, a series of prototypes were funded by the French state, yet few led to successful programs. The most successful ones eventually equipped the French air force and included a series of Dassault machines (Ouragan, Mystère, Super Mystère), which culminated in the series of Mirage fighters, from the model III and its variants to the F-1 and 2000 N in the 1990s. Several international programs involving France resulted in the supplying of the SEPECAT Jaguar ground attack jet and the Dassault-Dornier Alpha Jet.

The air force is also responsible for troop and VIP transport. Transports have included the Noratlas twin-engine (in use from the 1950s until the late 1980s) and the C-160 Transall. Longer-range aircraft have included DC-8s, later replaced by Airbus A-310s. Acquisition of the new Airbus A-400M transport is under consideration.

Women play a role, albeit a limited one, in the French air force. Female convoy pilots served in World War II and continued the practice afterward, adding medical evacuation to female duties during the Indochina War. Pilot Valérie André became the first female general in all the French armed forces in 1976. By the 1980s, women were also undergoing training as fighter pilots.

Guillaume de Syon

See also

Algeria; Dassault Mirage III; Dassault Mystère IVA; Indochina; Suez Crisis

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French Aircraft Development and Production (World War I–Early World War II)

The development of French aircraft up to World War II depended initially on aviation pioneers who became aircraft builders. The first company established as such, in 1905, was that of Gabriel Voisin, who oversaw the building a full-fledged aircraft factory near Paris. Other companies soon appeared, such as Blériot, Breguet, and Farman.

At the beginning of World War I, the French aircraft industry consisted of a mix of small aircraft factories producing fragile machines of varying quality. Under the leadership of Commander Edouard Barrès, by October 1914 a new streamlined plan of production was put in place that included license production, aircraft design according to specific missions, and the opening of new factories as the economy shifted to support the war effort. However, the lack of priority given to air armament affected the development of new aircraft, and it was not until 1917, when Colonel Charles Duval was called in to help solve such problems, that the aircraft industry gained priority. With the end of the war, however, the end of standing orders for machines placed such pressure on aircraft manufacturers that several went out of business (Voisin closed in 1920 and shifted to automobiles and some engine production). Still others, however, slowly began to enter the scene, as was the case of Marcel Bloch, a young aeronautical engineer who had gained prominence after designing the éclair propeller. Others, such as Henri Potez, produced remarkable machines in response to state contracts, yet by the 1930s the French aeronautical industry was in a funk.

Failures in innovation combined with increased foreign competition meant that from 1918 to 1928 the number of aeronautical firms had shrunk from 40 to 28, with another 10 making motors. Attempts to remedy this problem with the creation of an air ministry in 1928 yielded limited results, as the world economic crisis dried up foreign orders and political instability shook France. Some notable progress did occur, however, in the establishment of a flight-test center (CEMA, a rough equivalent to the U.S. NACA) at Villacoublay. Its recommendations, however, were often overlooked by constructors. With the change of government in 1936 to a left-wing coalition, a massive wave of nationalization ensued, led by Air Minister Pierre Cot and designed in part to save the French aircraft industry. This affected both research and production programs. No attention was paid to organizational culture and specialty, and in several cases companies had to fight hard to retain some control over their research laboratories, whose innovative processes would otherwise have been limited.

Six major groups fell under the umbrella of the Société Nationale de Constructions Aéronautiques (SNCA, for National Aircraft Building Company):

- N (nord/north): ANF Les Mureaux, CAMS, and a part of Breguet
- O (ouest/west): Another part of Breguet as well as Loire-Nieuport
- SO (sud-ouest/southwest): Bloch, Blériot-SPAD, and a section of Lioré and Olivier
- SE (sud-est/southeast): Potez, SPCA, and a section of Lioré and Olivier
- C (centre/center): Farman and Hanriot
- M (midi/south): Dewoitine

Other private manufacturers who specialized in light aviation were able to survive (such as Amiot and Caudron), though contracts often dried up for them. The impact of such a nationalization process was immeasurable. Companies that declined the initial buyout offer (such as Breguet) saw contract attributions reversed. (The Bre-690, though initially selected as a fighter, was then rejected in favor of the less able Potez 63.) New processes of engine allocations, contracts, and subcontracts meant slippage in schedules and slow workmanship, although some remarkable projects still appeared. The Amiot 370, for example, was a brilliantly designed twin-engine machine derived from the Amiot 340 bomber and successfully bested several speed records in 1938. Only one was built, however, and the bomber from which it had been extrapolated was never properly tested.

When France was invaded in 1940 and the Third Republic fell, Germany took over French factories in its zone of occupation and began production of its own machines and parts (such as the Fi 156 Storch). In the Vichy zone, production of aircraft was authorized only to fill in the ones lost in combat to the British by the Vichy air force. As for transport projects, these were the only ones whose production was fully authorized (such as the SE 200 giant hydroplane). A couple of projects underwent secret development (i.e., on paper), such as the SO 6000 Triton, which after 1945 became the first French jet aircraft to fly. Overall, however, the French aeronautical industry was dead in the water, producing barely 8,000 aircraft (compared to 35,000 in Germany). More than a decade would be necessary to effect a recovery.

Guillaume de Syon

See also

French Aircraft Development and Production (Post–World War II); Vichy French Air Force

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French Aircraft Development and Production (World War II–Present)

The state control of major French aircraft factories after 1936 had shown a lack of understanding for efficient industrial and technological development. The high costs associated with regional aircraft constructors as created before World War II affected the rebirth of the French aircraft industry after World War II. Combined with socioeconomic hardship, the French aircraft industry lagged behind other nations. Although the government awarded contracts for local production, the lack of immediate availability of French machines forced a reliance on U.S. and British productions.

However, the French government also wished to regenerate its own aircraft industry and to replace the 6,000 aircraft lost to war, obsolescence, and attrition. There was a split, however, between the need to keep government-owned factories going by producing proven German designs, and that of encouraging private companies. Such was the case of constructor Marcel Bloch, who, upon returning from a German concentration camp, faced opposition from communist members of the government regarding his restarting his factory. However, he was able to capitalize on the French air force's needs for a more rationalized fleet that could replace the ragtag surplus aircraft obtained from Allied (and even German) sources. Thus, while the Morane-Saulnier factory manufactured a French version of the Fieseler 156 Storch liaison plane (the MS-500 Criquet), Bloch, who had changed his name to Dassault, bid and won a contract for the twin-engine MD 315 Flamant transport. In the meantime, a new trend affected all French aircraft manufacturers, whereby the government, based on experience from the war bombings, now required that aircraft factories be moved outside of cities and placed near airports.

In engine production, France lagged behind the United States and Great Britain and required several years to catch up to the standards developed during World War II. In jet development, however, all countries involved had a roughly equal start. France, using the services of Hermann Oestrich, formerly of BMW, began the study of the Atar jet engine program. Consequently, the French government encouraged its factories to develop jet prototypes, but the requirements placed on these projects were often far too optimistic, prompting the production under license of the de Havilland Vampire and of the Rolls-Royce Nene jet engine. It was not until Dassault produced the Ouragan jet fighter in the early 1950s (acquired by the French, Indian, and Israeli air forces) that the French aerospace industry slowly began to catch up to its competitors.

In the meantime, the experience of the Korean War prompted the French high command to identify two new programs, one for a light attack aircraft, the other for a NATO-standard supersonic interceptor, which would later become the Mirage.

The trends that had characterized French aerospace production before World War II changed rapidly in the 1950s. Several pioneer names disappeared from the rosters. Some, like Morane-Saulnier, went bankrupt by the early 1960s and were acquired by other aircraft producers (in this case, by Sud Aviation). Others, like Latécoère, ceased production of major aircraft projects to focus on parts manufacturing and subcontracts. A third category—private designers who hoped to emulate the practices of early pioneers—generally failed in their attempts to secure full state support and left the scene. For example, René Leduc designed a series of ramjet aircraft prototypes but lost funding in the late 1950s in the wake of the political and economic crisis that characterized the end of the Fourth Republic. Others, like Hurel-Dubois, producer of the twin-engine HD-34 survey aircraft, went into subcontracting.

With the advent of the Fifth Republic under the initial leadership of President Charles de Gaulle, the French aerospace industry experienced a new wave of financial backing and new project development. Several of these had begun years before, as was the case for the Mirage prototype and the atomic bomb feasibility study, but funding, coupled with a more clearly defined foreign policy that emphasized French independence, boosted such projects. These included the Dassault Mirage IV nuclear bomber as well as SLBM and ICBM development (by a national factory known as SEREB) for the newly developed French atomic bomb (first tested in 1960). There also appeared international cooperation programs like the SEPECAT Jaguar ground attack jet, the Dassault-Dornier Alpha Jet trainer, and, on the civilian level, the Concorde and Airbus projects.

At the industrial level, further consolidations occurred, notably with the forced acquisition of Breguet by Dassault (prearranged by the French state). Other companies, including previously nationalized ones, eventually joined with SNCASE (also known as Sud Aviation) and SNCAN (Nord Aviation). Both giants eventually underwent their own integration when, on 1 January 1970, the Société Nationale Industrielle Aérospatiale became the new entity and included the SEREB.

A similar process affected engine manufacturers, which earlier had become part of the nationalized SNECMA, builder of the Atar engine used on many jet fighters. Several private companies continued to prosper, such as Dassault, Messier (landing gear), and Matra (missiles), but the lion's share of contracts went to Aérospatiale, which became heavily involved in several international construction projects, notably Airbus Industrie and Eurocopter (a result of the fusion of its helicopter division with the German firm MBB). However, by the turn of the millennium, things had evolved once again toward pan-European integration, and Aérospatiale, after merging with the Matra concern, became part, along with the major other European manufacturers, of the EADS consortium.

Of the few independent companies that remain, Dassault Aircraft continues to prosper in both aircraft and avionics development. Attempts at cooperation in the design of a new Eurofighter (the Typhoon) failed in the 1980s, primarily on political grounds, and led to the design of a new Dassault fighter, the Rafale.

By 2000, the French aerospace industry had become a major player on the commercial and military market, helping maintain France in the top-five weapons-exporting nations. New avenues of prosperity, first chartered in the 1980s, began to yield considerable returns in the communications and observation satellites business as well as the booster market (Arianespace).

Guillaume de Syon

See also

Dassault; French Air Force; French Aircraft Development and Production (World War I–Early World War II); Potez Aircraft

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French Army Light Air Force

The French army's interest in aviation dates from the nineteenth century, with ballooning. The Revolutionary Army had made use of a balloon at the Battle of Fleurus in 1792, and a century later several pioneers considered the use of military dirigibles.

As of 1909, however, with the flight of Louis Blériot over the English Channel, military circles began to focus anew on the potential of military aviation. Several dirigibles were involved in military maneuvers during the 1910–1914 period. When World War I broke out, airplanes and dirigibles were responsible primarily for observation. One such airplane patrol allowed General Joseph Galliéni to shift his troops to meet German forces making their way toward the Marne River. In time, artillery support became more important, and by the end of the conflict the army had 1,600 planes specifically assigned to that task.

During the interwar years airpower doctrine evolved considerably, and in 1934 the Armeé de l'Air (French Air Force) was formally established as a separate arm. This shift meant that the army was on its own to devise a new air support and intelligence doctrine, as the air force was focusing more and more on bombing and air interception. Further disagreements on the use of light aviation in the French army and air force were suspended by France's defeat in 1940.

The appearance of U.S. light aircraft (Piper L-4s in particular) to support the U.S. naval artillery in Operation TORCH in North Africa, so impressed members of the Free French Forces that they demanded their ground forces be equipped with their own aviation support units.

Although French army air units saw service in the liberation of France, it was during the summer of 1945 that the newly formed Ministry of Defense, in light of the French air force's professed limited interest in observation missions, ordered the creation of an artillery aviation capability for the army. However, the air force failed to carry out the order, and the army found itself dependent on a few observation machines—but without any operational structure.

France's colonial wars would soon force the problem to resurface. In Indochina, artillery planes would be used heavily for VIP transport and reconnaissance purposes, hardly ever for artillery fire. Soon, Cessna L-19 aircraft replaced aging Morane-Saulnier 500 Criquet machines (French versions of the Fi 156 "Storch"). Meanwhile, the first helicopters appeared and were used for medevac purposes. They included Hiller UH-12As, H-19s, and H-23s and Sikorsky S-53s and S-55s. However, the moment the French Indochina War ended in 1954, the French air force, mindful of budgetary constraints, took over all rotary-wing aircraft, creating considerable tension with the French army.

However, based on lessons learned in Indochina, the French army started defining a new operational doctrine that included air mobility, antitank capacity, and general combat. Consequently, on 22 November 1954, the army's light aviation observation unit merged with its first helicopter group to form the Army Light Air Force (ALAT). It was immediately put to work in Algeria, where helicopters were used for tactical troop drops (using formations of six H-21s in a "helicopter intervention detachment"). Other operations included ground attack, using modified Bell 47 G-2s carrying either machine guns or wire-guided French SS-10 missiles, later Alouette 2 platforms with SS-11s. Other technical experiments in the field would include arming H-21s with rockets and guns and even an H-34 with a 20mm cannon. By the 1960s, ALAT had almost 700 planes and close to 400 helicopters at its disposal.

The effective use of helicopters and planes during the Algerian War proved that the army did not need the air force to effectively deploy an aviation force; this would be confirmed in 1962, when the French government gave the army autonomy in the formation of its pilots. Two army aviation groups were then stationed in Germany while another two remained in France, each comprising about 20 planes and 20 helicopters.

In 1977, in response to new technologies and military requirements, five combat helicopter regiments were created and divided into reconnaissance, attack, and maneuver squadrons. The helicopters used include an assortment of Aerospatiale/Eurocopter Dauphin, Ecureuil, and Puma machines, with plans for the acquisition of the Tiger attack helicopter.

Guillaume de Syon

See also
Algeria; French Air Force

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French Missile Production and Development

The first consideration of missile development in France came about through the suggestions of René Lorin, an artillery officer, whose description of an "aerial torpedo" in 1915 would have involved a remotely controlled piston-engine machine. A variant applying the principle of the ramjet engine was also discussed but never developed. In the meantime, in 1916, aerial rockets of the "Le Prieur" type were put to use against tethered observation balloons.

In the interwar years, little attention was paid to the potential of missiles and rockets, other than through the theoretical work of pioneer Robert Esnault-Pelterie and the tests of rocket bombs in 1936 by Camille Rougeron. In fact, applied missile development in France began only after World War II—based on German results. Consequently, production followed several tracks in relation to the demands of each service.

The French navy became very interested in the potential of sea-launched antiship missiles and acquired antisubmarine Malafon missiles for the defense of its carrier battle groups, adding the Masurca surface-to-air system in the late 1960s. In 1967, when Soviet-built SSN2-A Styx missiles, fired by Egypt, destroyed the Israeli frigate *Eilath,* the idea of a sea-launched antiship missile came to prominence in France.

Although a series of short-range rockets also entered service, the major industrial production in the 1970s and 1980s was the Aérospatiale Exocet missile, which first entered service in 1974. Available in several versions, including surface-to-surface and air-to-surface, this missile was sold to several navies throughout the world, including Germany, the United Kingdom, and France. It gained notoriety when an Argentine fighter fired an Exocet at HMS *Sheffield* and sank it during the Falklands War in 1982. Meanwhile, the French army ordered the development of several antitank missiles, using the SS-10 and SS-12 systems. Other systems included the internationally procured MILAN.

The French air force also commissioned the construction of several missiles, particularly air-to-ground and air-to-air missiles for various missions. The first French air-to-air missile was Matra's R 511. Variants of the American Sidewinder were also used, alongside the Matra 530 and later the Matra 550 Magic. The AS 30 air-to-ground vector, developed by Nord Aviation (later part of Aérospatiale), entered service in 1961 and was based on the air-to-air AA 10 and AA 20 missiles. It was followed by the Franco-British AS 37 Martel antiradar unit, which equipped both Mirage IIIEs and Jaguar aircraft.

Other French missile developments grew as part of international programs designed to cut costs as well as ensure equipment compatibility wherever possible among European forces. For example, France and Germany worked together on the development of the infantry antitank MILAN missile system, designed to succeed the SS 10, SS 11, and Cobra systems. Begun in the 1960s, the MILAN concept entered service a decade later. Several other projects are the result of Franco-German teamwork, through such companies as the Euromissile Corporation, in which groups from Aérospatiale and Germany's MBB work together updating MILAN and developing other projects. The most recent consortium work revolves around the Apache missile, for which the French air force placed a $225 million order in 1997. Equipped with the French-built Prométhée radar, the Apache uses Inertial Guidance System/Global Positioning System navigation to reach the target, then switches to radar for the final phase of its flight.

As for ballistic missiles, the French government began feasibility studies in the late 1950s, partly in response to Soviet and U.S. efforts in that field. Eight types of experimental missiles were tested between 1960 and 1965, leading, among other things, to the first orbiting of a French satellite atop a Diamant rocket in 1965. The other result was the knowledge accumulated toward the development for ground-to-ground strategic ballistic missiles. The first such machine was the S112 two-stage rocket, tested seven times (with four failures) between 1965 and 1967. Tests of other models, the S01 and S02, were more successful. A similar path came about in the development of submarine-launched ballistic missiles (SLBMs). At the same time, the French army began considering the use of tactical missiles, which eventually included the Hades and Pluton rockets, designed to carry tactical nuclear weapons.

The production of France's ballistic missiles was initially assigned to the National Society for Explosives and Powder for the propulsion material and to Aérospatiale for the missiles themselves. Eighteen S2 missiles were placed in silos on the Albion Plateau in 1972, replaced eight years later by S3 types. As for SLBMs, M1 missiles first equipped submarines starting in 1972, followed by M20 vectors in 1977. The most recent missile, the M4, carrying six warheads, began operation in 1985. An upgraded M4, the M40 SLBM, is scheduled to enter service; ground-launched ballistic missiles were retired from service in the late 1990s.

In parallel, Aérospatiale developed a new cruise missile, the ASMP (medium-range air-to-ground), for use onboard the Mirage IV and later the Mirage 2000N. Capable of carrying a 200-kiloton nuclear warhead, the ASMP can cruise over a maximum distance of 250 kilometers if released from high level. A newer version, with longer range, should enter service around 2008.

Guillaume de Syon

See also

French Air Force; French Naval Air Force

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French Naval Air Force (Aéronavale)

From the very beginning of military aviation, the French navy considered using aircraft to further carry the missions it was assigned. In World War I, it used a number of planes for coastal patrol and convoy escorts. Pilot training initially took place at a naval base as well as the French army's Istres airfield. Soon, however, a new naval air base was set up at Berre. Most machines were hydroplanes from the Georges Lévy factory, which were soon replaced by the float-modified Farman 60 "Goliath" and various other types.

In the interwar years, the navy's air arm also played a role in enforcing French control over its colonies, for example, by setting up bases in Indochina.

By the mid-1930s, the navy used several squadrons of torpedo-bomber hydroplanes, among them the Levasseur PL 15 and Latécoère 290. These were then replaced by the Latécoère 298, a torpedo-bomber, which first flew in 1936, entered the service in 1939, and remained active until 1950. In the meantime, the navy placed into service the *Commandant Teste,* a hydroplane carrier, which launched machines from special catapults and collected them through an access hangar near the ship's waterline.

In World War II, the navy also used the *Béarn* as an aircraft carrier. After 1945, the navy reorganized its aeronautical section, dividing it into squadrons for maintenance and training and flotillas for combat. Under this system, neither was automatically linked to an aircraft carrier, as had been the case with the *Béarn* and *Commandant Teste* carrier groups.

As part of its plans to fulfill its NATO-assigned duties, France first used aircraft carriers obtained from the United States and United Kingdom. However, these carriers (*La Fayette, Bois-Belleau, Dixmude,* and *Arromanches*) were also used to support air operations in the Indochina War and later in Algeria. There, the navy deployed squadrons of Grumman Hellcats, Curtiss Helldivers, and Chance-Vought Corsairs.

In addition, Grumman Goose amphibians were used to drop French commandos while Consolidated Privateers ensured air surveillance. Other aircraft, some used for carrier training, included Spitfires and Grumman Bearcats. With the advent of the jet age, training of naval pilots was first done in CM 175 "Zephyr" jets. Later, qualifications were done in Dassault Etendard IVMs (until 1990) and then in the Super Etendard.

Aware of the shortcomings of World War II–era carriers, France opted for new ships in the late 1950s rather than refurbishing of older ones. Two French-built attack aircraft carriers, R98 *Clémenceau* and R99 *Foch* (25,000 metric tons, equivalent to the U.S. *Essex* class) entered service in 1961 and 1963 and served as the main vector of power projection until retired in the 1990s.

During that time, the de Havilland Aquilon, a French naval version of the de Havilland Sea Venom used for both defense and attack purposes, reached retirement. There were no acceptable French replacements for the machine, so France purchased 46 Vought F-8E(FN) "Crusaders," which remained in service until 1999. The Dassault Etendard, used for attack purposes, was replaced by navalized Jaguar jets. Although both R98 and R99 served French interests with great distinction, their lack of nuclear power and limited size suggested that they would eventually be unable to support power projection in any meaningful way. Indeed, during the Balkan crisis of the late 1990s, R98 was retired, leaving R99 to do the work and requiring it to return regularly to port. In the meantime, the French parliament approved funding for a new nuclear-powered ship, the *Charles de Gaulle,* that began sea trials in 1999 and will carry the first squadrons of navalized Dassault Rafales. Though the new ship will allow for effective power projection on European seas and in the context of UN and NATO operations, the French navy finds itself at a crossroads, currently lacking the means to fund a second aircraft carrier.

Nonetheless, the Aéronavale continues to render great service, as it can use other vectors to ensure its goals are carried out. These include nuclear-powered submarines that carry France's nuclear missile deterrent, as well as various battle cruisers equipped with Exocet missiles. Furthermore, several coastal bases are available from which to launch air patrols, notably in the form of Dassault-Breguet 1150 Atlantic submarine hunters.

Guillaume de Syon

See also

French Air Force; French Missile Production and Development

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FREQUENT WIND (1975)

U.S. code name for the final evacuation operation from Saigon, South Vietnam (Republic of Vietnam, RVN). In the early morning of 29 April, a People's Army of Vietnam (PAVN, the North Vietnamese Army) rocket and artillery barrage against Tan Son Nhut Air Base announced the final assault on the RVN capital. As the last U.S. fixed-wing aircraft departed the battered air base, Major General Homer D. Smith, head of the U.S. Defense Attaché Office (DAO), informed U.S. Ambassador Graham A. Martin that the runway at Tan Son Nhut was unusable. He recommended the execution of Option IV, in which U.S. and Vietnamese refugees would be evacuated by helicopter to U.S. Seventh Fleet ships waiting 80 miles offshore.

Martin decided to come to Tan Son Nhut for a firsthand inspection. At 10:51 A.M., he issued orders to begin Option IV. This was followed by radio broadcasts of Bing Crosby singing "White Christmas," the signal for Americans to proceed to evacuation points. At 2:53 P.M., with the temperature reaching 105 degrees, 865 Marines arrived via CH-53s to cover the evacuation.

Over the next seven hours, 4,500 Vietnamese and 395 Americans were flown out. Around 11:00 P.M., the last Marines departed, destroying classified equipment and facilities as well as $3.6 million in U.S. currency.

Originally, no plans had been made for a major rescue from the U.S. Embassy. By late afternoon, the embassy Marine commander, Brigadier General Richard E. Carey, reported that several thousand stranded Vietnamese and Americans had gathered in or around the embassy compound. Quickly, 130 additional Marines were flown in to defend the area. Since only one CH-53 at a time could land in the compound's parking area, they were augmented by CH-46s flying off the embassy's rooftop.

Except for a brief delay to evacuate the DAO, a steady stream of helicopters made hundreds of round-trips to the waiting ships. By 4:30 the next morning, with growing concerns that the embassy might be overrun by PAVN forces, Carey gave orders that thereafter only Americans were to be airlifted. Around 5:00 P.M., Ambassador Martin and the last American departed. About 420 Vietnamese were left waiting in the parking area.

Elsewhere in Saigon, hundreds of other Vietnamese who had worked for the U.S. military, embassy, and Central Intelligence Agency were left behind. All told, 1,500 Vietnamese and 978 Americans were rescued from the embassy. At daybreak, only the Marine security forces remained inside. Nine CH-46s finished evacuating them at 7:53 A.M., the last man to leave being Master Sergeant Juan Valdez aboard *Lady Ace 09.*

U.S. helicopters flew 662 sorties. They lost two Marine guards to ground fire and two CH-46s that crashed at sea. About 8,800 evacuees were eventually brought to Subic Bay, in the Philippines, including 989 Marines. Some 675,000 Vietnamese refugees eventually made their way to the United States after the Vietnam War.

William Head

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Frontal Aviation

Branch of the Red Air Force that controlled tactical air assets supporting ground operations. The concept for Frontal Aviation evolved during the interwar period and the Great Patriotic War (the Soviets' name for World War II) as the Soviet military developed its concepts for rapid, deep offensive operations. The designation was based on the fact that the Frontal Aviation units were assigned directly to a front commander—a senior Red Army officer—for conducting combined arms operations.

A front (roughly equivalent to a group in a Western army) was a Soviet command echelon subordinate to a theater of military operations. A front controlled multiple armies, including Frontal Aviation units formed into an air army. Normally, a single air army was assigned to each front, although more could be assigned if the front was the main axis of attack. Additionally, strategic resources from Long Range Aviation forces (and later nuclear missiles) could be assigned to augment the Frontal Aviation effort.

During the Cold War period, each military district and each Soviet group of forces outside the Soviet Union included an air army in its military structure. Air armies normally included several air divisions, each of which controlled three regiments, each containing three squadrons. Frontal Aviation played an important role in the successful campaigns in the latter portion of the Great Patriotic War and in the planning for operations during the Cold War. Frontal Aviation operational concepts emphasized preparation for and then support of combined arms ground offensives. Preparation operations would begin with an air offensive that was designed to gain air superiority by attacks on the airfields, air defense assets, and command and control facilities.

The preparation phase would also provide reconnaissance on enemy dispositions, suppress enemy firepower capabilities (especially in the nuclear era), and disrupt enemy movement to the main axis of attack. Support for ground offensive operations emphasized air superiority, reconnaissance, and providing mobile firepower to enhance the offensive penetration and movement of offensive thrusts. In the post-Soviet period, the tactical resources of the Russian air force were organized under the Frontal Aviation Command, one of four commands of the Russian air force.

Jerome V. Martin

See also

Russian Air Force (Post-Soviet); Soviet Air Force; Tactical Air Warfare

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Fuchida, Mitsuo (1903–1973)

Led the Japanese air attack on Pearl Harbor on 7 December 1941. After World War II, he converted to Christianity and became a globetrotting evangelist.

In 1941, Fuchida was one of Japan's most experienced aviators. Although his comrades were killed off as the war progressed, he survived many close calls, including being recalled from Hiroshima the day before the atomic bombing. At the war's end, Fuchida took up farming.

On the way to testify at a war-crimes trial, Fuchida accepted a pamphlet written by Jacob DeShazer, a member of the Doolittle Raid. The Japanese had captured and tortured DeShazer, but he became a Christian from reading the bible in prison and returned to evangelize Japan. Fuchida realized DeShazer's forgiveness was like that of Peggy Covall, who had helped Japanese POWs even though Japanese soldiers had beheaded her missionary parents. Intrigued, Fuchida purchased a bible and, after reading it, also became a Christian.

Eventually, Fuchida traveled the world as an evangelist. Once he shared the platform at a West Berlin crusade with Billy Graham. He regretted ever leading the Pearl Harbor raid.

Emerson T. McMullen

See also

Pearl Harbor

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G

Gabreski, Francis S. (1919–2002)

Top-ranking U.S. World War II ace in Europe. Francis S. "Gabby" Gabreski was born in Oil City, Pennsylvania, the son of Polish immigrants. In 1940, after attending college for two years at Notre Dame, he joined the U.S. Army Air Corps. In March 1941, he was commissioned a second lieutenant in the U.S. Army Air Corps and was assigned to the 45th Fighter Squadron of the 15th Fighter Group at Wheeler Field, Hawaii, where he flew the Curtiss P-40 Warhawk.

Gabreski was anxious to get into the European conflict, so he volunteered to transfer to one of the Polish squadrons flying with the Royal Air Force. Because he was fluent in Polish, his application was accepted and he was assigned to Northolt, the home of six Polish Spitfire squadrons. He was attached to No. 315 Squadron, flying the highly regarded Spitfire Mk.IX fighter in several missions with the Poles.

On 27 February 1943, Gabreski was assigned to the 61st Fighter Squadron of Hub Zemke's famed 56th Fighter Group, flying the Republic P-47 Thunderbolt. He was soon appointed commander of B flight, and on June 9 he was promoted to major and given command of the 61st Fighter Squadron.

On 24 August 1943, Gabreski scored his first aerial victory. From then on, kills came more frequently, often by doubles and triples, until he recorded his twenty-eighth victory on 5 July 1944. He was the leading U.S. ace in Europe and, after almost 200 missions and 500 combat hours, had earned a rest.

On 20 July 1944, while waiting to depart for the United States, Gabreski abruptly decided to fly one last mission. After encountering no fighter opposition, he elected to strafe a German airfield near Coblenz. On his second very low pass, Gabreski's propeller contacted the ground, forcing him to crash-land in a nearby field. He evaded capture for five days before the Germans finally apprehended him. He spent the remainder of the war as a POW in Stalag Luft I.

After the war, Gabreski stayed in the military, gaining further experience flight-testing and commanding fighter units. When the Korean conflict erupted, Gabreski—now a colonel—once more went to war, this time flying the North

Gabby Gabreski shot down 31 planes in Europe before becoming a prisoner of war. As wing commander of the 51st Fighter Group, he scored six-and-a-half victories flying F-86s in Korea, becoming one of the few who were aces in both wars. (U.S. Air Force)

American F-86 Sabre Jet. He was once again a phenomenally successful fighter pilot, with 6.5 MiG-15s to his credit. This ensured his membership in the very select club of pilots who achieved ace status in two wars.

In 1967, after 34.5 total confirmed aerial victories in two wars and numerous command positions, Gabreski—now the third-ranking U.S. ace of all time—finally ended his distinguished military career. After retirement from the Air Force, he served as an executive with Grumman Aircraft Corporation and as president of the Long Island Railroad.

His numerous decorations include the Distinguished Service Cross, and in 1978 he was honored by being elected to the National Aviation Hall of Fame in Dayton, Ohio. He died of a heart attack on 31 January 2002.

Daniel Ruffin and Steven A. Ruffin

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Gagarin, Yuri (1934–1968)

First person to orbit Earth. Born in Klushino (Russia), Gagarin was trained as a major in the Red Air Force. Chosen for the historic space flight on 8 April 1960, Gagarin lifted off on 12 April 1961 aboard a Vostok capsule. The flight lasted 108 minutes. Following his success, Gagarin became a great hero in the Soviet Union whose appeal to the public was comparable to that of Charles Lindbergh in the United States.

Although Gagarin stated several times that he wished to fly again into space, Soviet authorities preferred to keep him on the ground, where his value as a symbol of the Soviet Union at home and abroad continued to grow. Officials eventually conceded that they might allow him another orbital flight if Gagarin completed his engineering studies, interrupted in 1961.

In 1967, to his surprise, he was also allowed to fly aircraft again. Gagarin finished an honors thesis (the title of which remains classified), received his diploma on 8 February, then undertook jet training. On 27 March 1968, Gagarin was flying a two-seater MiG-15 UTI with instructor-pilot Colonel Vladimir Seryogin when the plane crashed, killing both occupants. The accident report, classified for 20 years, concluded that the crash was the result of pilot error combined with atmospheric conditions. He was buried with full military honors; an obelisk was erected at the site of the crash.

Guillaume de Syon

See also

Korolyov, Sergei; Vostok

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Gallai, Mark (1914–1998)

Soviet military test pilot. Mark Lazarevich Gallai was born on 16 April 1914 in Saint Petersburg, Russia. After graduating from an engineering institute and flight school, he became a test pilot for TsAGI (Central Aerodynamics and Hydrodynamics Institute), where he remained for his entire career except for three brief periods of combat flying during World War II, primarily for the sake of field-testing. He was honored as a Hero of the Soviet Union on 1 May 1957 and in 1959 was given the title Honored Test Pilot of the Soviet Union. In 1957, he retired from the air force and thereafter continued his test-flying and research as a civilian focusing on flight dynamics. In 1972, he was awarded a Doctorate of Technical Sciences. He died on 14 July 1998.

George M. Mellinger

Galland, Adolf (1912–1996)

Legendary German fighter pilot and commander; undoubtedly the best-remembered veteran of the Luftwaffe. Galland joined the still-secret German air force in 1934. He gained an excellent reputation in the Spanish civil war as the leader of a squadron of ground attack aircraft, and he fought in the Polish campaign in that capacity. He transferred to fighters and was named commander of Jagdgeschwader 26 (JG 26; 26th Fighter Wing) in August 1940, one of the first of the younger generation of fighter pilots to be promoted to that level of command. By the end of the Battle of Britain, Galland's innovative escort formations had become standard doctrine, and JG 26 had earned a reputation as the best fighter unit in the Luftwaffe.

Galland led JG 26 in France until December 1941, when he was summoned to Berlin to replace Werner Moelders as General der Jagdflieger (General of the Fighter Arm) after the latter's death. He was soon awarded the Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross, the second member of the Wehrmacht (after Mölders) to receive this new highest decoration. At age 30, Galland became the youngest general in the Wehrmacht. His new job was a staff rather than a command position, and Galland spent three frustrating years attempting to defend the interests of the fighter force within the Luftwaffe High Command.

Reichsmarschall Hermann Goering tended to blame the failures of his fighter arm on the cowardice of his pilots rather than deficiencies in numbers, training, and equipment. Galland, although a favorite of Hitler's, gradually lost all credibility and influence in his position, and he resigned in January 1945. He requested and was granted permission to form a small unit of Me 262 jet fighters, Jagdverband 44, and led it until he was wounded in April 1945. Galland ended the war as a lieutenant general. His final victory total was 103, all scored against the Western Allies.

Galland served after the war as a technical adviser to the Argentine air force, and after his return to Germany he became a consultant to the German aviation industry. He remained active until his death in 1996. His classic memoir, *The First and the Last,* established his reputation in the English-speaking world and remains in print in several languages nearly a half-century after its original publication.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Garros, Roland (1888–1918)

Pioneer French aviator. Roland Garros was part of the cadre of pilots who achieved fame at air shows, races, and aviation contests in the days prior to World War I. And like his comrades, when war was declared he volunteered.

Over the war's first winter, he began collaborating with Raymond Saulnier on the problem of firing a gun through the propeller. Settling on the attachment of steel wedges to the propeller as protection, Garros tested the device in the spring of 1915. His "tests" resulted in three victories over German aircraft before he became the victim of engine failure over enemy lines. Along with his secret weapon, Garros was captured and became a POW.

Escaping in 1918, Garros returned to the front flying SPADs. He was shot down on 5 October 1918, this time losing his life. A Paris sports stadium is named in his honor.

James Streckfuss

See also

Morane-Saulnier Aircraft

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Gasoline

A liquid hydrocarbon extracted from crude oil. Gasoline has also been produced from natural gas and coal. The energy content of gasoline is 18,500–19,000 btu/lb, and it weighs 5.9–6.0 lbs/gal.

Early straight-run (distillation process) gasolines were of varied and limited quality, quite prone to "knock" or detonation in high-performance aircraft piston engines. World War I experience soon demonstrated that the knocking tendency was related to the crude oil characteristics from which it was derived. The increased aromatic content in crude oils from the Dutch East Indies and Southern California fields resulted in greater knock resistance than gasolines distilled from Pennsylvania crudes, for instance.

The dreadful quality of early gasolines, typically having an octane rating of around 50, resulted in the use of fuel blends to improve knock resistance. Benzol, a mixture of benzine, toluene, and a small amount of xylene blended with gasoline, derived from California oil fields was frequently used in pursuit and racing aircraft engines of the 1920s and early 1930s.

High-performance aviation gasolines available to the United States and its Allies during World War II were due in no small part to the earlier discovery that tetraethyl lead was a very effective knock inhibitor. This additive, together with improved refining methods and blending such compounds as iso octane with gasoline, led to development of 100-octane aviation fuel.

Development of aviation fuels was a vital factor in the dramatic progress achieved by the aviation industry during the 1920–1940 period. It was absolutely essential to the aircraft engine industry and facilitated ever larger and more powerful piston engines. The adoption and use of high-quality aviation fuels by the Allies was a major contributing factor to victory in World War II.

Birch Matthews

Gavin, James Maurice (1907–1990)

U. S. Army general who charted a new course for Army aviation. As commander of the 82d Airborne Division in World

War II, Gavin learned about air mobility. Service after the war in a group evaluating nuclear weapons development and as commander of VII Corps in Germany convinced him that the Army had to prepare for tactical nuclear warfare. Knowing that the Soviet Union was developing tactical nuclear weapons, Gavin exercised VII Corps in nuclear scenarios. He found it necessary to disperse and assemble the corps rapidly to avoid nuclear annihilation. The corps could not perform these exercises satisfactorily using its ground transportation and communications.

Assigned to the Army staff as the deputy for operations and later director of Army research and development, Gavin spent the remainder of his career seeking solutions to the problems of tactical nuclear warfare. The solution that he found was to develop new missions for Army aviation so that troops could disperse, assemble, and resupply rapidly by using helicopters and light transport airplanes. To scout enemy lines, he proposed mounting cavalry in helicopters. To acquire enemy targets suitable for nuclear weapons, he desired Army reconnaissance airplanes transmitting real-time intelligence to commanders. To enable helicopter-borne troops to attack hostile targets, Gavin sought to arm helicopters and procure light bombers under Army control. Gavin also created the position of director of army aviation to assure that the Army moved in these new directions.

As director of research and development, Gavin helped develop tactical missiles, new and better helicopters, vertical takeoff and landing aircraft, and equipment suitable for the nuclear battlefield.

Gavin's ideas pushed the Army into conflict with the Air Force over roles and missions. The services compromised in the 1960s, the Army securing armed helicopters but giving up light transport airplanes and light bombers.

Although Gavin retired in 1958, his ideas came to fruition later with the integration of Army aviation into the combat arms and the creation of Army divisions integrating air cavalry and air assault missions. Never used in nuclear war, these units have proven effective in counterinsurgency and conventional warfare.

John L. Bell

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Geisler, Hans-Ferdinand (1891–1966)

German general. Hans-Ferdinand Geisler was born in Hannover on 19 April 1891. He entered the German navy as a cadet in 1909 and was promoted to *Leutnant (*second lieutenant) on 19 September 1912. He served in the navy throughout World War I and the Weimar era, rising to the rank of commander, then transferred to the new Luftwaffe on 1 September 1933. Geisler was promoted rapidly from *Oberst* (colonel) on 1 March 1934 to *Generalleutnant (*lieutenant general) on 1 April 1939, and finally to *General der Flieger* (general of fliers) on 19 July 1940. He was awarded the Knight's Cross on 4 May 1940. He commanded Fliegerdivision 10 (redesignated X Fliegerkorps one month later) from September 1939, until his retirement. Geisler's first wartime command was in Hamburg, against British naval forces in the North Sea. He was later transferred to Sicily in support of Mussolini's troops. From 24 August to his retirement on 31 October 1942, Geisler was posted as special duty officer to the Air Ministry and commander in chief of the Luftwaffe. For his service, he received the German Cross in Gold on 9 November 1942. Geisler died in Köln-Kalk on 25 June 1966.

Suzanne Hayes Fischer

Gemini Space Program

The second manned U.S. space project. Gemini bridged the Mercury and Apollo programs and worked out most of the technical problems needed to reach the moon. Goals such as extravehicular activity, rendezvous and docking, the use of fuel cells instead of batteries, and spacecraft maneuverability—all necessary aspects of lunar missions—were achieved. The program additionally gave two new classes of astronauts a chance to fly with the original seven veterans.

Between 23 March 1965 and 15 November 1966, U.S. astronauts spent 1,940 hours in space—a far cry from the 54 hours accumulated during Mercury. Significant advancements in only four additional missions came with the development of better spacecraft able to support the two-man crew for much greater lengths of time. The Gemini 7 crew set a record: 14 days in space. Such extended trips would be vital for the 250,000-mile lunar journeys planned for Apollo.

In addition to its extended duration, Gemini 7 also participated in a space first as Gemini 6 (actually launched nine days after Gemini 7) met up and flew within a few yards of Gemini 7. This difficult rendezvous was the most vital part of a lunar mission.

Another requirement, such as the ability to work outside in space, was met with Edward White's Gemini 4 spacewalk, a first for America. Skeptics' theories that a man would perish in an atmosphere-void space environment were disproved.

U.S. astronauts were now ready to go to a place man had always dreamed of: the moon.

Erich Streckfuss

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Genda, A. Minoru (1904–1989)

Commander and later captain in the Imperial Japanese Navy. Genda was born in Hiroshima on 16 August 1904 and graduated from the Japanese naval academy in 1924. He attended flight school from December 1928 to November 1929 at Kasumigaura and graduated with honors in the nineteenth class. Genda later spent a year in England as the assistant naval air attaché, which helped him to become an expert on fighter aircraft and tactics as well as one of the navy's most respected officers. In 1941, Genda was picked by Admiral Isoroku Yamamoto to plan the air attack on Pearl Harbor. Genda served throughout the war in many capacities. In 1944, he took command of the 343d Air Corps, an elite flying group based at Matsuyama Air Base that was the cream of the remaining Japanese fighter pilots.

Postwar, Genda served as Chief of Staff of the Japanese Air Self-Defense Force (1959–1962); he also served in the House of Councilors (the Japanese parliament) from 1962 until 1986.

David A. Pluth

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General Dynamics

U.S. aircraft manufacturer and major defense contractor. General Dynamics has a complex history, with many firms and some famous names: Thomas-Morse, Dayton Wright, Stinson, Vultee, Convair. The company was founded in 1952 when Electric Boat, the Connecticut-based maker of submarines for the U.S. Navy, voted to change its corporate name to better represent its widening acquisitions. The company was involved with aviation ever since it purchased control of Canadair in 1946.

General Dynamics moved to the forefront of U.S. aviation with its takeover of Consolidated Vultee in 1953 to become the Convair Division. Convair had just completed the manufacture of the huge B-36 for the Air Force and was manufacturing jets, including the F-102 and later F-106 delta-wing fighters. San Diego operations were closed down after 1961. Fort Worth manufactured the B-58 and then the controversial F-111, though that program was curtailed in scope. By 1990, the firm and its predecessors had manufactured more than 100 basic types of airplane and produced more than 62,000 aircraft.

Because of declining Pentagon weapons purchases and general industry consolidation, as well as changing company interests, General Dynamics began to move out of aviation. Canadair was sold to the Canadian government in 1976. It took control of Cessna (private and business aircraft) in 1985 but sold that company to Textron just seven years later. Most important, it sold the huge Fort Worth division (formerly Convair) to Lockheed in 1993 for $1.5 billion and the remainder of its aircraft structures business to McDonnell Douglas the next year. The Space Division (which included the Atlas rocket fundamental to many space launches, among other missile and space products) was sold to Martin Marietta in 1994. With those sales, General Dynamics was essentially out of the aviation business for five years, concentrating instead on land and amphibious combat systems, information systems and technology, and marine products. Then, in mid-1994, it purchased control of Gulfstream Aerospace, a 1978 spinoff from Grumman that manufactured jet executive aircraft; this purchase returned the firm to aviation.

Christopher H. Sterling

See also
Cessna Aircraft; Consolidated Aircraft Corporation; Convair B-58 Hustler; Convair F-102 Delta Dagger and F-106 Delta Dart; General Dynamics F-111 Aardvark; Grumman Aircraft; Lockheed Aircraft; Lockheed Martin F-16 Fighting Falcon; Martin Aircraft

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General Dynamics F-111 Aardvark

A technically advanced multimission aircraft, perhaps the most controversial fighter ever procured by the U.S. Air Force. Conceived as the TFX by Secretary of Defense Robert McNamara—a "common" aircraft that could fulfill fighter, attack, reconnaissance, and bomber roles for both the Air Force and Navy—the F-111 suffered from numerous technical and political problems during its development and initial service. The F-111 was the first operational fighter equipped with variable-geometry wings (so-called swing wings that could sweep forward and back depending on conditions), afterburning turbofan engines, and an escape capsule for the crew. It was also the first operational attack aircraft capable of supersonic performance while flying less than 100 feet from the ground. The Navy bowed out of the program when the resulting aircraft was deemed too heavy to operate safely from aircraft carriers.

Eventually, the F-111 developed into a highly successful long-range interdiction aircraft—its early Vietnam experience notwithstanding—and saw limited service during several strikes against Middle East targets. An electronic warfare variant also proved remarkably effective, especially during Operation DESERT STORM in 1991. The first F-111A was flown on 21 December 1964, and 573 aircraft had been completed when production ended in November 1976. These included 79 FB-111As for the Strategic Air Command. An order for 50 F-111Ks for the Royal Air Force was canceled in January 1968 before any aircraft were delivered, but 24 F-111Cs were completed for the Royal Australian Air Force, which subsequently accepted six modified F-111As and 15 F-111Gs (formerly FB-111As) as attrition aircraft. Interestingly, the F-111 did not have an official name until 27 July 1996, the same day the type was retired from U.S. service. The Australians intend to continue operating their aircraft for the foreseeable future.

Dennis R. Jenkins

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George, Harold Lee (1893–1986)

U.S. general who oversaw the military's transport command. Harold Lee George was born on 19 July 1893 in Somerville, Massachusetts. He delayed his studies when World War I began, becoming a second lieutenant of cavalry in the Officers Reserve Corps. In October 1917, he resigned his commission to enroll as a cadet in the Army Signal Corps Aviation Section flying school at Love Field near Dallas, Texas. He received his wings on 29 March 1918.

In September, he joined the 7th Aviation Instruction Center, American Expeditionary Forces Air Service, in Clermont, France. During the Meuse-Argonne Offensive in October-November 1918, George flew bombers for the 163d Bomb Squadron. During this time, he became an adherent of General William "Billy" Mitchell's theories of airpower.

In June 1921, First Lieutenant George was one of a select group of young airmen who participated with Billy Mitchell in his famous aerial demonstration attack and sinking of the German prize battleship *Ostfriesland.* It galvanized George's belief in strategic bombing.

Captain George matriculated to the Air Corps Tactical School (ACTS), Maxwell Field, Alabama, where in 1934 he became the director of the Department of Air Tactics and Strategy. It was at ACTS that George expressed and developed his theories of institutional independence and offensive airpower: massed bomber formations carrying the battle to the enemy's heartland and destroying its ability and will to wage war.

Promoted to major in July 1936, George went to the Air Corps General Staff School for one year before going to Langley Field as commander of General Headquarters Air Force's 96th Bombardment Squadron and later its only B-17 unit, the 2d Bombardment Group. In February 1941, George was promoted to lieutenant colonel and in July was appointed assistant Chief of Staff for war plans in the newly created Air Staff in Washington. George chaired a board of officers developing Air War Plans Division (AWPD) Plan-1.

In April 1942, he was promoted to brigadier general and assigned command of the Air Corps Ferrying Command (ACFC). In June, ACFC became the now famous Air Transport Command. Major General George took a command of 130 antiquated transports and 11,000 personnel and built it into a force of more than 3,000 modern aircraft and 300,000 personnel.

For his dedicated service George received the Distinguished Service Medal, Legion of Merit, Distinguished Flying Cross, and Air Medal. He died on 24 February 1986 at age 92.

William Head

See also

AWPD/1 and AWPD-42

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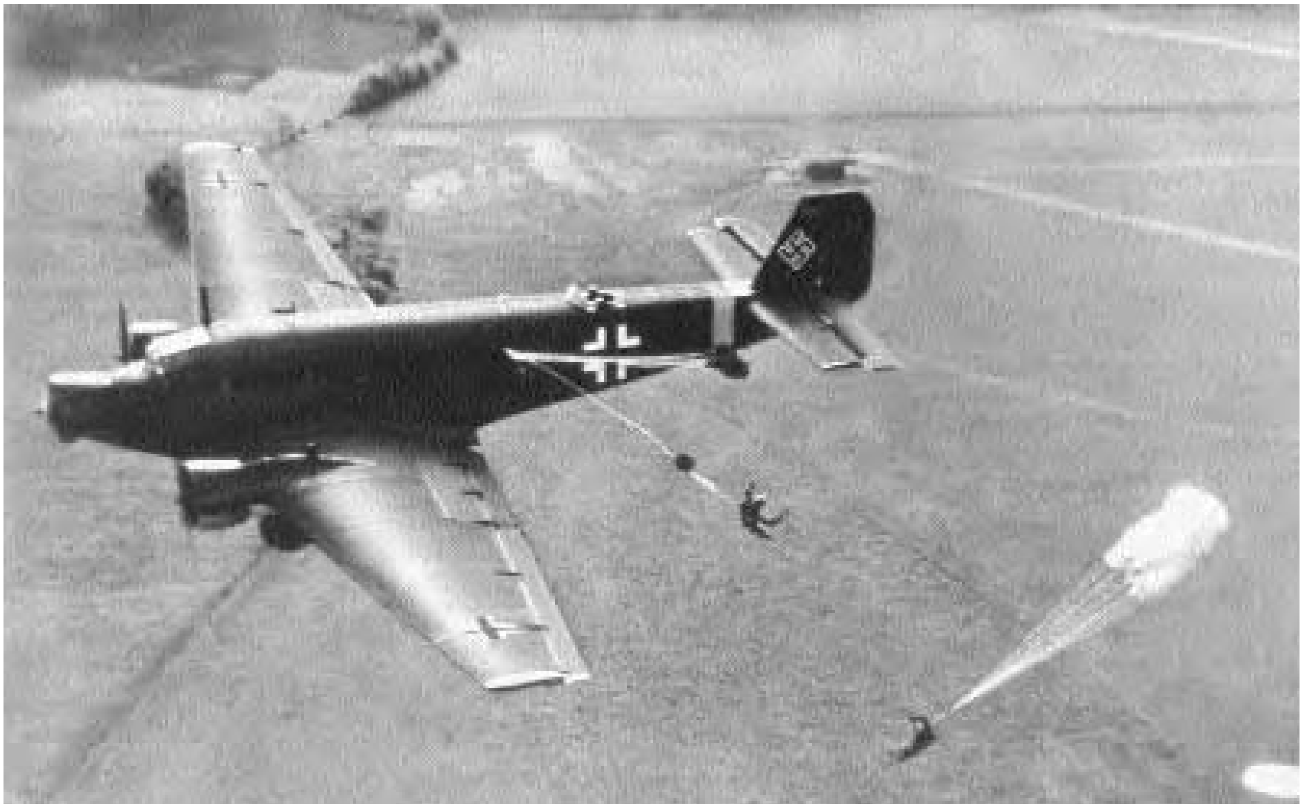
German Air Force (Luftwaffe, World War II)

Germany's revitalized, semisecret air arm that came to dominate the skies over Europe during the early blitzkriegs of World War II. After the Armistice to end World War I, the Al-



Junkers Ju 52/3m aircraft specialized in dropping paratroopers early in the war. (Walter J. Boyne)

lied victors limited Germany to a 100,000-man military. With no more than a token force and with enemies on its borders, Germany quickly established research programs in whatever areas it could—particularly rocketry—deemed militarily insignificant by the victors; it also established clandestine programs in areas prohibited by treaty. German civilian aviation was preeminent in Europe during the interwar years.

With the assumption of power by Adolf Hitler in the mid-1930s, remilitarization began in earnest. To create a viable air force, Germany had to develop synthetic fuels, establish a military organization from scratch, and find money to pay for multiple simultaneous programs. All programs suffered from funding shortages, but the Luftwaffe had a strong advocate in Hermann Goering, a World War I hero. Germany then used the Spanish civil war as a testing ground for close air support and other innovative tactics and gained hands-on education for Luftwaffe pilots and commanders.

By 1938, the Germans were more technologically advanced than their enemies in many areas, including the Knickebein blind-bombing system. The German leadership elected to maintain a Luftwaffe of about 5,000 aircraft but did not pursue research and development as they might have done. By 1942, German leaders realized—all too late—that they had fallen behind; they were forced to use updated versions of planes they had used against Poland years before.

Leaders had been deceived by the fact that in the battles of 1939 and 1940 (e.g., Poland, the Low Countries, France, Britain) the Luftwaffe appeared to have the edge, for it won relatively easy victories. But because the Luftwaffe was stretched thin, it fell victim to stagnation and then attrition. The Allies had better resources, more research and development, industrial capacity, manpower, technology, money, leadership, and plans. The Allied forces quickly surpassed the Luftwaffe in sheer numbers and, eventually, technical capability in most areas.

The Luftwaffe met its first defeat at the hands of Air Marshall Sir Hugh Dowding's Fighter Command over Dunkirk during the heroic evacuation of Allied troops in mid-1940. Another defeat was administered in the Battle of Britain—the opening move in a planned German invasion—shortly thereafter. Then by staking everything on the invasion of the Soviet Union, Hitler plunged Germany into a war it could no longer win. As early as 1942, German flight schools were turning out barely enough pilots to replace those lost, even though their training was half the length of Allied training. When it was apparent that Allied airpower was growing at a pace the Luftwaffe could not match, Germany turned to the production of "wonder weapons" as a last-ditch alternative. The resources devoted to the V-1 and V-2 rocket weapons would have been better spent on revamping the German aircraft industry.

When the United States entered the war, it was only a matter of time before Germany lost. By 1944, the Allies possessed long-range fighters to escort their bombers, took command of the air, forced the Luftwaffe to protect German airspace, and were able to control the air over the beaches of Normandy. German night-fighter resistance continued almost unabated through March 1944, but day-fighter resistance was overcome by then.

The Luftwaffe was unable to cope with the massive bombing by day and night, and German industry was forced to disperse. Then, when tactical fighters could roam over Germany, the German transport system collapsed. By the second half of 1944, the Allies could select targets by category—synthetic-fuel plants, for instance—and systematically reduce their capacity to less than 50 percent.

The Luftwaffe's failure to repel the Allied air offensive was costly. Antiaircraft batteries absorbed 10,000 guns that could have been used as airborne antitank weapons, and the half-million artillerists could have been better used in the workforce or at the battle fronts. Battered by the Allied fighter force, the Luftwaffe by June 1944 was reduced to only 1,375 fighters on all fronts. This number was insufficient to hold back the invading Soviet forces in the East or repel the Allied bombers from the West. The Luftwaffe had been bankrupted, thanks in great part to inept leadership. The collapse of the German homeland was inevitable.

John Barnhill

See also

Britain, Battle of; Dunkirk

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German Air Service (Luftstreitkräfte, World War I)

Germany began organizing an aviation service during the last few years of peace prior to the outbreak of World War I. At the beginning, there were two types of units making up the Luftfahrtruppe (Aviation Troops): the *Feld Flieger-Abteilung* (Field Flying Section), a mobile unit equipped with two-seat aircraft, and the *Festungs Flieger-Abteilung* (Fortress Flying Section), a similar force attached to a fortress. Each unit had six aircraft.

The Festungs Flieger-Abteilung quickly disappeared from the German order of battle, but the Feld Flieger-Abteilung remained, the number expanding over the years, but the mission remaining the provision of the entire range of aviation services.

By 1916, it was clear that the self-contained air force approach in vogue at the beginning of the war was not an efficient way to run military aviation. The situation had been evolving gradually, with such innovations as the spinoff of single-seaters into independent *staffeln* (squadrons) previewing the coming reorganization of units around their intended mission. During the Battle of the Somme, the Luftfahrtruppe was reorganized and became the Luftstreitkräfte (Air Service) under the command of a former cavalry officer, General Ernst von Hoeppner.

Two other features distinguish the German service from that of the Allies; one was political, the other doctrinal. On the political level, Germany was made up previously independent and still semiautonomous states, and the larger of those other entities had to be accommodated by the creation of their own units. Thus, the years 1917 and 1918 saw the creation of Bavarian, Saxon, and Württemburg units.

On the doctrinal level, the Germans adopted a defensive posture. Having to conserve assets in consideration of a two-front war and the British blockade, such a policy made sense. Occasionally, it cost opportunities—notably at Verdun, where an aggressive approach against the *voie sacre* (sacred road) may have proven a tactical advantage.

The Luftstreitkräfte continued as an effective force until the end of the war despite the fuel and equipment shortages that plagued its final months.

James Streckfuss

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German Aircraft Development and Production, Post–World War II

In 1945, the victorious Allies dismantled and banned Germany's ability to produce civil and military aircraft as well as other implements of war, presumably for all time. By 1955, however, the Cold War had ushered in a radical change. Two separate German states now existed, and each had been drawn into the orbits of the two remaining superpowers: the Soviet Union and the United States. The Federal Republic of Germany (West Germany) voluntarily joined NATO; the German Democratic Republic (communist East Germany) entered the Warsaw Pact.

In West Germany, the establishment of armed forces meant the resumption of aircraft production. Initially (and for many years thereafter), the resurrected Luftwaffe operated primarily U.S. aircraft. These included the Republic F-84F Thunderstreak fighter-bomber, the Luftwaffe's first jet. Following closely were North American F-86K Sabres and, in the 1960s, Lockheed F-104G Starfighters and McDonnell F-4s and later F-4Fs.

From the beginning, however, indigenous production also contributed to the Luftwaffe's strength. Given sharply rising costs of development, many of the domestically produced aircraft came from international consortia involving German firms. For example, German-French programs produced the Nord Noratlas in the 1950s and, a bit later, the Nord-MBB C-160 Transall (in 2000 only on the verge of replacement). These hard-working twin-engine transports supplied airlift for infantry, paratroops, and cargo. A complementary German-Italian program produced the nimble Aeritalia (FIAT) G91 ground attack/reconnaissance jet, which resembled a scaled-down version of the F-86K.

Another program involving the veteran German manufacturer Dornier and the French company Dassault resulted in the Alpha Jet. This nimble trainer/ground attack fighter did yeoman's service in the Luftwaffe. In more recent years, a European consortium with heavy German participation, Panavia, has produced the very successful and combat-tested Tornado in several variants. They include the Tornado ADV (Air Defense Variant), the terrain-following Tornado IDS (Interdictor/Strike; Gr.Mk.I), and the German Tornado ECR, which is used for wild-weasel missions.

A next-generation replacement for the Tornado is yet another consortium-produced aircraft, the Typhoon. Produced by Eurofighter GmbH, which includes Germany's leading aerospace manufacturer, DASA, the Typhoon first flew in 1994.The Luftwaffe confidently expects the Typhoon to be Europe's leading air superiority/strike aircraft as it enters operational service.

The aerial war over Kosovo in 1999 demonstrated several of Germany's—and Europe's—military deficiencies. These included a lack of airlift, aerial refueling, and command and control aircraft. In part to redress the balance, Airbus Industrie, which includes major German participation, has established the Airbus Military Company to produce the A-400M, a four-engine turboprop-driven tactical transport. The A-400M will replace the Luftwaffe's remaining C-160 Transalls and complement the A310–304 multirole twinjet airlifters already in service. In addition, DASA has joined AirTanker, a new European company bidding to produce the Future Strategic Tanker Aircraft (FSTA). Aircraft such as the FSTA and A-400M will, it is hoped, decrease future German (and European) dependence on combat support elements of the U.S. Air Force.

D. R. Dorondo

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German Imperial Naval Air Service (World War I)

The Imperial German Navy took an early interest in aviation. The Danzig Imperial Dockyard began seaplane research in early 1911 on orders from Grossadmiral Alfred von Tirpitz and soon issued broad specifications, initially for amphibians. Domestic industry responded poorly, at first forcing purchase of foreign machines, but later supplied indigenous aircraft.

When World War I started, the navy operated only nine seaplanes and a single airship, deployed to protect approaches from the North Sea and the Baltic, but soon expanded its air arm. Grossadmiral Prince Heinrich, the kaiser's younger brother and an ardent naval-aviation advocate, took command of forces in the Baltic. There he aggressively used aviation, deploying seaplanes with the fleet for forward reconnaissance, torpedo attack, and aerial minelaying.

North Sea commanders also appreciated aviation's value. Airships significantly enhanced the fleet's reconnaissance capabilities. Senior commanders viewed seaplanes as important not only as scouts but also for offensive operations and antisubmarine patrol. The Zeebrugge air station soon became a key base for German offensive and defensive operations in the North Sea.

The navy generally eschewed flying boats, although Dornier developed some very large examples late in the war. Industry supplied rugged patrol seaplanes, large twin-engine torpedo carriers, single-seat fighters, and the excellent Hansa Brandenburg two-seater biplane and monoplane fighters that were serious threats to patrolling British airships and flying boats, submarines, and small craft. By war's end, the German navy deployed more than 1,100 seaplanes at 32 naval air stations along the coastlines of the Central Powers.

The navy also built up a substantial land-based front-line force in Flanders to defend its bases, expand reconnaissance coverage of the English Channel, and eventually support naval infantry at the front. By late 1918, it deployed more than 100 modern landplanes, roughly divided between single-seat fighters of the Marinefeldgeschwader (Marine Field

Squadron) and two-seaters in reconnaissance and ground support units.

During World War I, the Imperial German Naval Air Service grew from nine seaplanes to more than 1,500 aircraft (excluding airships). Aircrew increased from 20 officer pilots to more than 2,100 officers and men supported by a further 14,000 ground personnel (another 6,000 officers and men served with 16 airships). The service significantly enhanced the fleet's capabilities throughout the conflict. After the air service demobilized (1919–1920), Germany's navy never again operated its own organic air arm.

Paul E. Fontenoy

See also

Aircraft Carriers, Development of; Airships; Dornier Aircraft; German Naval Airship Division; Gotha Aircraft; Heinkel Aircraft; Zeppelin, Ferdinand von

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German Naval Airship Division

Created in 1912 to exploit a new weapon: the rigid airship. The brainchild of Ferdinand von Zeppelin, these giant lighter-than-air craft served two purposes. The more valuable, though less colorful, task performed by airships was fleet reconnaissance. The long endurance of airships provided an uninterrupted aerial platform and a third dimension to naval operations, lengthening the range of view to unprecedented distances.

The other mission was the bombing of England. This campaign, the obsession of Commander Peter Strasser, counts as history's first attempt at strategic bombing. Results achieved were less than impressive, a final accounting documenting slightly more than £1.5 million in damage and minimal loss of life. The losses incurred and the expense of the Zeppelins led to their being abandoned as a primary weapon and replaced by large bombing aircraft. Zeppelins conducted almost 1,000 reconnaissance missions over the North Sea in support of the Imperial German Navy.

A vital lesson that was not learned from the failure of the bombing—by both Zeppelins and aircraft—was that civilian morale rises to the occasion rather than breaking under attack. This hard lesson was learned a second time in the 1940 Battle of Britain.

James Streckfuss

See also

Airships; Balloons; World War I Aviation

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German Rocket Development

Both sides used rockets in World War I. Afterward, the Allied victors lost interest, focusing research efforts on tanks, planes, and the other successful weapons from that war. But Germany continued its rocket research, and the Verein für Raumschiffahrt (Society for Space Travel) was established in 1927 in Breslau. The first successful rocket test took place in 1930, with other tests following, but by 1934 the amateur society was defunct. The German army took over rocket testing, consistent with its practice from the 1920s of working illegally with Russia on weapons research. The army sought a better artillery weapon, so the research was in the ordnance department.

In 1932, Wernher von Braun joined army rocket research at Kummersdorf. The first test of a 650-pound/thrust motor fueled with alcohol and liquid oxygen fed into the combustion chamber by nitrogen failed when the engine blew up. Undaunted, von Braun and staff designed the Aggregate 1 (A-1) rocket.

The A-1 was 4.5 feet long with a 1-foot diameter and a takeoff weight of 330 pounds. The engine developed 650 pounds/thrust for 16 seconds. Stabilization was built in as a design factor; the nose of the rocket spun, serving as a gyroscope. Before launch, an electric motor revved it to 9,000 rpm, and it ran down during flight. The first three A-1 tests at Kummersdorf failed.

Even before the first A-1 test, the A-2 was designed with the same 650-pound/thrust engine but separate fuel and liquid oxygen tanks with a gyroscope in the middle close to the rocket's center of gravity. A-2 tests relocated from Kummersdorf to preserve secrecy (by this time the Nazis were in power and suppressing information and amateurs). Von Braun's 1934 Ph.D. thesis called his work "combustion experiments."

In December 1934, two A-2s were launched successfully at Borkum (and were named *Max* and *Moritz,* after the Katzenjammer Kids) from a 40-foot launch platform. They attained 1.4 miles of altitude and landed, with a parachute assist, approximately 800 meters from the launch point. When the army asked him about the weapon potential of the A-2, von Braun noted that conventional artillery had the same capability.

In March 1935, Hitler repudiated the Versailles Treaty and the buildup was on, including at Kummersdorf (renamed Experimental Station West). The A-3 was on the drawing board, and the Army Ordnance Office began a cooperative effort with the Luftwaffe that eventuated in the center at Peenemünde.

Peenemünde was in northern Usedom. Its conversion to a test center began in 1936. By 1937, the Kummersdorf contingent could relocate except for engines, which remained at Kummersdorf until 1940. Peenemünde provided a clear 300-kilometer firing range, harbors, and all other required facilities. Most noteworthy was its supersonic wind tunnel, which initially was smaller than the one at Aachen that tested up to Mach 3.3. By 1942, the capability of the wind tunnel at Peenemünde exceeded Mach 4.4, the best in the world until after the war. Peenemünde also had a small rocket production facility.

The A-3 was 21 feet, 8 inches long and 28 inches in diameter; its takeoff weigh was 1,650 pounds. Inside the nose was a telemetry package to measure heat and pressure in flight. There was a guidance system to control attitude, a liquid oxygen tank and nitrogen reservoir, and a parachute container. In the rear was the 6-foot-long motor, encased in the alcohol tank, with 1.5 tons/thrust. The rocket had four fins and jet vanes in the nozzle for better early-flight control and in the thin upper atmosphere, where fins were ineffective.

The A-3 took nearly two years to build because of difficulties developing a guidance system. A combination of four gyroscopes spinning at 20,000 rpm to control yaw and pitch helped keep the rocket level. The 1937 test on the island of Greifswalder Oie failed because the gyro system could not control beyond 30 degrees and could not correct the A-3's tendency to turn into the wind. Because the A-3 had not burned or exploded, the group felt confident enough to develop a small A-5 to refine the new technologies. The A-4 was the designation for the military rocket that became the V-2.

John Barnhill

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Germany and World War II Air Battles (1940–1945)

Greatest aerial campaign in history, involving the air forces of the United States, Great Britain, Germany, and the Soviet Union. As early as 1939–1940, Royal Air Force units executed reconnaissance and leaflet-dropping raids over Hitler's Reich. The RAF began more serious operations even as the Luftwaffe blitzed the home islands. On the night of 15–16 May 1940, RAF bombers struck targets in the Ruhr Valley. These operations culminated in raids on Berlin itself in August. Flown primarily by Vickers Wellington, Armstrong Whitworth Whitley, and Handley Page Hampden twin-engine machines, the raids caused little actual damage but did help boost British morale and heralded things to come.

These early British attacks were hampered by several factors. The RAF lacked long-range escort fighters; the bombers had insufficient defensive firepower; bombsights were inaccurate, as was navigation; and the bomb-carrying capacity was low. These inadequacies forced RAF Bomber Command to turn to area-bombing, or city-busting. The subsequent introduction of four-engine Handley Page Halifax and Avro Lancaster heavy bombers and the leadership of Sir Arthur "Bomber" Harris enabled Bomber Command to overcome some of these handicaps.

These developments occurred in the face of a German air force whose greatest strength in interceptors would not be reached until the summer of 1944. The German fighter force would include some formidable aircraft, including the Messerschmitt Bf 109, 110, and 410, the Focke-Wulf Fw 190, and a handful of Messerschmitt Me 262 jets late in the war.

Meanwhile, Bomber Command's efforts slowly intensified through 1941. Bremen, Hamburg, and Kiel were bombed, in part because they were easily located at night. As for specific targets, the RAF concentrated first on oil production facilities and, later, rail centers in the Ruhr. The Luftwaffe, however, countered with the introduction of the Liechtenstein air-to-air radar system, and Bomber Command's losses increased.

New equipment, such as the Gee radar system, allowed relatively accurate all-weather bombing by night, and losses temporarily fell. Essen, Lübeck, and Rostock were all successfully attacked in March and April 1942. On 30–31 May, the RAF's first 1,000-plane raid took place, made possible by Harris's scraping together every available aircraft, including those from training units. Cologne was heavily bombed, and only 41 bombers were lost, a manageable rate of 3.8 percent. This raid's size surprised the Germans and equally heartened the British.

More important, it gave Bomber Command a new lease on life just as the U.S. Eighth Air Force became active against Germany from bases in the United Kingdom. The consequent accretion of Allied strength, coupled with the Luftwaffe's growing commitments in North Africa, over the Mediterranean, and in Russia, would eat into the latter's reservoir of aircrews, the training establishment, and, eventually, the production of aircraft. The initiation of the Allies' Combined Bombing Offensive took shape at the Casablanca Conference in January 1943.

It was first manifested in the RAF's Battle of the Ruhr. On 5 March, 442 heavy bombers attacked Essen. Twin-engine de Havilland Mosquitos equipped with Oboe direction-finding radar led the way. These were the first of more than 18,500 sorties flown against targets in the Ruhr by the termination date of 14 July. Of the bombers dispatched, 872 failed to return; another 2,126 suffered damage.

In the meantime, U.S. Eighth Air Force bombers made their first daylight raid on Germany on 27 January 1943. Of 91 bombers dispatched, 55 Boeing B-17 Flying Fortresses attacked the German navy's U-boat facilities at Wilhelmshaven. Others bombed Emden. Consolidated B-24 Liberators accompanying the mission, unable to find their targets due to weather, returned to base with their bombs. No aircraft were lost. It seemed an auspicious first use of heavily armed four-engine daylight raiders over Germany.

Before 1943, the Luftwaffe's principal task lay in devising effective night-fighting techniques to counter British operations. This was largely accomplished through the development of radar-directed flak batteries and searchlights using two variants of a system called Würzburg. This system could also be used for vectoring night-fighters to their targets. A subsequent, complementary device (Freya) came to be used for early warning. The resulting combined system, Himmelbett, was eventually arranged in a north-to-south line through northwestern Germany and the Low Countries to provide the so-called Kammhuber Line (named after Major General Josef Kammhuber, its principal advocate).

Although attacks by Bomber Command and the Eight Air Force continued almost daily thereafter, two high points were reached in the summer and fall of 1943. In the first instance, combined daytime and nighttime assaults on Hamburg in late July resulted in the first-ever devastation of a city by firestorm. Unusually good weather and the use of radar-jamming foil strips (Window, or chaff) allowed Allied bombers to swamp the Germans' defenses and burn out the heart of the city. Some 50,000 Germans were killed, another 40,000 injured, and yet another 1 million driven out. But that same month also saw the Luftwaffe's first use of a new aerial weapon. On 28 July, interceptors fired 210mm air-to-air rockets into Eighth Air Force bomber formations, knocking three B-17s from the sky. German night-fighters also began to overcome the RAF's radar-jamming efforts as the summer waned.

The second high point witnessed the Eighth Air Force's attacks on ball-bearing factories at Schweinfurt and the Messerschmitt aircraft plant at Regensburg. In two separate efforts in August and October 1943, the USAAF lost 120 heavy bombers. Hundreds of others were damaged, and thousands of air crewmen were killed and wounded. Though U.S. fighter escorts had first entered German airspace in July, deep-penetration raids were flown without cover due to the escorts' limited combat radius. Appalling losses to the bombers were the result. Despite the activation of the USAAF's Fifteenth Air Force in Italy in November (for attacks on southern Germany, Austria, and the Balkans), the Allies appeared to lose the initiative in the air war as 1943 drew to a close.

In part to offset any resulting ill effects, Bomber Command launched the Battle of Berlin on the night of 18 November 1943. As over Hamburg, the RAF bombed at night while the Eighth Air Force eventually attacked by day, its first raid over the city occurring on 4 March 1944. U.S. bombers assaulted the Reich capital three more times that month, flying 1,700 sorties and being accompanied now by long-range escort fighters, most notably North American P-51 Mustangs. Although reduced in strength, the Luftwaffe could still fight back. On 6 March, for example, 69 U.S. bombers were lost to flak and interceptors. Although Berlin was badly damaged, the destruction did not cost Germany the war, as planners (especially British planners) had assumed it would. Nevertheless, by early 1944 the Luftwaffe had stationed 75 percent of its fighter strength in the West within Germany proper as a result of the bombing campaign. That disposition helped denude fighter forces from other theaters, despite an actual increase in total German fighter strength through the summer of that year.

The USAAF's BIG WEEK attacks of 20–27 February 1944 broke the back of the Luftwaffe fighter arm. Combined with the raids on Berlin and other cities, these attacks by Allied bombers and escorts cost the Luftwaffe approximately 1,000 pilots from January to April. This critical loss could not be overcome. Bomber production ceased and the Luftwaffe stripped its remaining fighter strength to skeletal remnants on all fronts to place 1,260 of an available 1,975 remaining fighters and fighter-bombers in the home-defense role as 1944 progressed. The turn of the year 1944–1945 saw the Luftwaffe hounded from every quarter.

The Luftwaffe's last offensive action, Operation BODENPLATTE (1 January 1945) achieved tactical surprise at enormous cost in attacks on Allied airfields across the Low Countries and northeastern France. Subsequent engagements over the Remagen bridgehead in March and Bavaria in April saw the frequent appearance of the Me 262 as well as the Arado Ar 234 Blitz, the world's first operational jet bomber. But even remarkable aircraft like these proved too little, too late to prevent the ultimate demise of Germany and the Luftwaffe.

D. R. Dorondo

See also

Berlin Air Battles; German Air Force (Luftwaffe); Hamburg Bombing Campaign; Kammhuber, Josef; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Gibson, Guy P. (1918–1944)

RAF commander. Guy Penrose Gibson was born in Simla, India, on 12 September 1918; he joined the RAF in August 1936.

During a successful flying career with the RAF, Wing Commander Gibson was quickly recognized to be an outstanding operational pilot and leader. He served with conspicuously successful results, mainly as a nighttime bomber pilot. Gibson is best known for commanding the famous No. 617 Squadron—the Dam Busters—formed for special tasks. Under his inspiring leadership, this squadron executed one of the most devastating attacks of World War II: the breaching of the Möhne and Eder dams. During the attack Gibson, showing leadership, determination, and valor of the highest order, flew a Lancaster bomber to within 50 feet of the water in order to deliver the bomb precisely. Gibson then circled very low for 30 minutes to draw enemy fire, thus permitting his squadron a free run to the target. Gibson received the Victoria Cross in 28 May 1943.

On 19 September 1944, at age 26, Gibson flew out of Woodhall Spa on a bombing mission in a Mosquito from No. 627 Squadron. After completing the bombing raid, Gibson went on to check antiaircraft positions and his Mosquito crashed, killing himself and his navigator, Squadron Leader J. B. Warwick. Gibson is buried at Steenbergen-en-Kruisland, the Netherlands.

Albert Atkins

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Gilbert Islands

Air operations in the Central Pacific to prepare for and support U.S. Marine amphibious invasion in 1943. The Gilberts, taken by the Japanese in early 1942, provided the first step in the Allied offensive in this theater. Throughout the fall of 1943, Allied land-based medium and heavy bombers attacked targets in the Gilberts from bases in the Ellice Islands and farther south. Task Force 50 of six heavy and five lighter carriers, the largest carrier force yet assembled, directly supported the landings and destroyed the remaining Japanese air forces on the islands. They also struck Japanese bases in the Marshalls, suppressing support from those islands. Another carrier task force raided air bases in the Solomons, preventing reinforcement from that theater.

U.S. Marines landed on Tarawa (Betio) and Makin on 20 November 1943 and took the islands with heavy casualties after three days of difficult fighting (Operation GALVANIC). Japanese attempts at air support from bases in the Marshalls were unsuccessful. There were no Allied naval losses to Japanese aircraft, although a Japanese submarine torpedoed and sank the escort carrier *Liscombe Bay.*

The Allied victory in the Gilberts provided the first solid validation of the ability of mobile carrier-based airpower to concentrate and overwhelm local land-based air forces.

Frank E. Watson

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Global Navigation Satellite Systems (GNSS)

A system employing one or more satellite constellations for the purposes of navigation. The requirement for a civil GNSS is rooted in the aviation community's worldwide need for precise navigation and a more efficient aircraft surveillance system.

Two GNSS constellations exist today: the Global Positioning System (GPS), built and maintained by the United States; and Russia's Global Navigation Satellite System (GLONASS). Eurocontrol, the European Union's civil aviation authority, made use of both the Russian and U.S. systems by employing geosynchronous satellites to form a third hybrid system: the European Global Navigation Overlay System (EGNOS). More recently, the European Space Agency, the European Community, and Eurocontrol have formed the Tripartite Group for the purposes of building an independent European GNSS. Named Galileo, this planned system will consist of both geostationary (GEO) and middle-earth (MEO) orbiting satellites owned and operated by the European Union.

GPS

The concept of a worldwide satellite navigation system for the United States began in the early 1960s with three governmental organizations: the National Aeronautics and Space Administration, the Department of Defense, and the Department of Transportation. The first attempt, Transit, became operational in 1964; however, it was limited to low dynamic, or slow-moving, transportation platforms such as ships. The Navy began its own program, Timation, to improve the concept of space-based terrestrial navigation. The Air Force, building on the Timation and Transit programs, began experimenting with a satellite system it named System 621B. In 1969, the secretary of defense established the Defense Navigation Satellite System (DNSS). DNSS created a single joint-use satellite system—NAVSTAR GPS—managed by the Joint Program Office (JPO).

The JPO maintains the current GPS constellation, ground-control equipment, satellite production, and maintenance functions; policy decisions are made by the Interagency GPS Executive Board formed 28 March 1996.

GLONASS

Russia's Scientific Production Association of Applied Mechanics began development of GLONASS under the auspices of Russia's Ministry of Defense in the mid-1970s. The system, originally designed for the navy, was applied to other military and civilian aviation missions. Within the Military Space Forces, the State Department of Space Means maintains and manages all aspects of the GLONASS system.

The first three satellites were launched on the same SL-12 Proton rocket from Kazakhstan on 12 October 1982. The system has yet to reach its planned constellation of 24 satellites due to the breakup of the Soviet Union and subsequent economic crises.

EGNOS

A feasibility study by the European Space Agency, Inmarsat, and the French National Center for Space Studies led to testing a concept using GEO satellites, such as INMARSAT-3, to augment both the GPS and GLONASS constellations. Testing proved the soundness of this concept, and INMARSAT began procurement of INMARSAT-3 satellites with the required navigation packages in 1989.

GNSS Navigation Fundamentals

GNSS satellites provide position, altitude, and velocity by utilizing time-of-arrival (TOA) and ranging concepts. The distance between the satellite and receiver is determined by measuring the elapsed time between transmission to receipt of the signal. Accurate positioning using the TOA concept requires that at least three satellites be in view, e.g., accessible by the receiver during use.

Both the GLONASS and GPS systems, originally built for military use, were designed with selective availability (SA) and antispoofing capabilities. SA denied precise navigational accuracy to anyone other than the military. However, both Russia and the United States have since ended SA, and both systems' precise positioning service is available for use by anyone with the appropriate receiver. Additionally, the Federal Aviation Administration has been developing terrestrially based Wide Area Augmentation Systems and Local Area Augmentation Systems to overcome inherent GPS inaccuracies and increase precision for aviation applications. The Europeans, however, have looked to a GEO satellite overlay system to provide increased accuracy.

Randy Johnson

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Gloster Aircraft

British aircraft manufacturer. Originally named the Gloucestershire Aircraft Company, the more marketable name "Gloster" came into use in 1926. The first vestige of the company had appeared in 1917 and built aircraft under license for the war effort.

Glosters suffered with others from the Great Depression, although it stayed in business and began to resume aircraft production with the Grebe in 1923. This was followed by the Gamecock, Gauntlet, and the famous Gladiator biplane fighter.

Gloster Aircraft became part of the Hawker-Siddeley Group in 1935, although it was to retain its individual identity. Throughout World War II, the company built many Hawker products before building the first jet-powered aircraft in the United Kingdom. The Pioneer was soon followed by the Meteor fighter. Supplied to the RAF, the Fleet Air Arm, and numerous overseas air forces, the Meteor was made in 14 different versions before production ceased.

The Gloster Meteor became a work horse for the RAF, serving many test purposes, including inflight refueling. (Walter J. Boyne)

Gloster was also the first company to address Britain's lack of a decent nighttime/all-weather fighter with the Javelin two-seater. The first flight of the prototype Javelin was undertaken in November 1951, with the type entering RAF service in 1956. The company identity finally disappeared in 1965 when it was fully integrated into the Hawker-Siddeley Group.

Kev Darling

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Gloster E.28/39 (G.40) Pioneer

The first gas turbine/turbojet–powered airplane to be designed, developed, and flown in Great Britain. After its initial static engine runs and taxi tests, RAF Flight Lieutenant Philip E. G. "Jerry" Sayer successfully took the Pioneer into the air for the first time on 15 May 1941. He performed speed runs at 2,500 and 4,000 feet during the 17-minute test hop at Hucclecote, hitting a top speed of 380 mph. Known as "Squirt," the radical plane had been developed under a strict RAF requirement (designated E.28/39), which called for a single-engine prototype to prove the feasibility of jet propulsion for a fighter-type aircraft. It was powered by a single Power Jets Incorporated 850-pound/thrust W.1 turbojet engine that was closely based upon a design patented by RAF Air Commodore Frank Whittle.

The chief of the United States Army Air Corps, General Henry H. "Hap" Arnold, set the wheels in motion for America to have its own jet-powered airplane. The E.28/39 paved the way for Gloster Aircraft to create Britain's first operational jet-powered fighter plane: the Gloster Meteor. It may be seen today at the Science Museum in London.

Steve Pace

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Gloster Meteor

Britain's first operational jet-powered fighter. The design of the Meteor began in 1940. A twin-engine layout was chosen due to the low power output of the available centrifugal jet engines. An initial batch of eight development aircraft was ordered, the first flying in March 1943. By this time an extended order for 100 production aircraft had already been placed.

First service deliveries to the RAF took place in July 1944 to equip No. 616 Squadron. Based at Manston, the Meteors joined the Tempests, Mustangs, and Spitfires of Air Defence forces in combating the menace of the V-1 flying bomb. Further developments of the Meteor resulted in the appearance of the Meteor III and Meteor IV, both of which featured improved engines as their main area of improvement. It was a clipped-wing Meteor IV that set a new world air speed record of 606 mph on 7 November 1945.

These early aircraft were followed by the definitive Meteor day-fighter: the F.8. More than 1,000 of this variant were delivered and stayed in RAF service until the final aircraft was retired in 1977. Two other single-seat versions were built: the FR.9, based on the F.8 fighter, and the PR.10, which owed more to the F.4 but with improved engines. The FR.9 was intended for low-level usage while the PR.10 replaced the reconnaissance versions of the Spitfire and Mosquito. The Meteor T.7 was the trainer version.

The final development of the Meteor married the center section and twin cockpit of the Meteor T.7 to the tail section of the F.8. The outer wing panels were borrowed from the earlier Meteor III, and the nose grew even more elongated with each mark. Built by Armstrong Whitworth Aircraft, the Meteor night-fighter encompassed four versions (Mks.11–14).

Meteors found many new roles, including target tug and navigation training tasks. The Fleet Air Arm operated the T.7 and the TT.20. Prior to settling upon the use of the Meteor for secondary tasks, the Fleet Air Arm had operated a small quantity of navalized Meteor IIIs.

As the first jet fighter to enter regular squadron service, the Meteor also attracted the attention of many foreign air forces. One of these was the Royal Australian Air Force, whose aircraft became embroiled in the Korean War. Other operators included Belgium and Holland in Europe; in Latin America, Brazil and Ecuador were among those to operate the type.

Kev Darling

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Gnôme/Gnôme-Rhône Rotary Engines

There were two major types of aircraft engines in World War I, serving two purposes. The water-cooled inline engine powered aircraft designed for missions that allowed time for advance preparation; the air-cooled rotary engine was designed for aircraft that had to be off the ground in a hurry. Gnôme-Rhône manufactured air-cooled rotary engines.

The rotary differed from inlines in that its cylinders spun with the propeller and its crankshaft remained stationery. Early versions also lacked a throttle so that it always ran either full-on or full-off.

Gnôme-Rhône products powered the entire range of Allied rotary-engine aircraft, including Nieuports, Sopwiths, and Caudrons. They also occasionally equipped German aircraft. The Fokker triplane, for example, which normally used a copy of the French LeRhône rotary engine, Oberursel, is reported to have sometimes been fitted with captured Allied engines. This occurred most often in the last months of the war, when the Allied blockade was making supply problems increasingly severe in Germany. Such hardships prompted German ace Joseph Jacobs to offer a case of champagne to soldiers who brought him a captured rotary.

Rotaries were limited in their development because of the torque effect of the mass of rotating cylinders. They reached their peak during World War I and disappeared from military inventories as technology progressed in the 1920s.

James Streckfuss

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Goddard, Robert H. (1882–1945)

Father of U.S. rocketry and inventor of the liquid-fuel rocket. Born in Worcester, Massachusetts, in 1882, as a youth Robert H. Goddard suffered from tuberculosis. Enforced rest gave the young man time to daydream and read science-fiction works by Jules Verne and H. G. Wells. One daydream about spaceflight proved so vivid that Goddard noted the date, 19 October 1899, in his diary and celebrated "Anniversary Day" thereafter. Four years behind his contemporaries when he entered Worcester Polytechnic Institute in 1904, he studied physics and tested solid-fuel rockets. After graduation in 1908, Goddard earned an M.A. and Ph.D. in physics from nearby Clark University. He completed a postgraduate fellowship at Princeton and then returned to Clark, where he held various academic ranks and positions for the next three decades.

As a faculty member, Goddard continued testing rockets, building stronger combustion chambers, and improving thermal efficiency. He patented (1914) the multistage rocket and proved experimentally rocket thrust in a vacuum (1915). The Smithsonian Institution awarded him a grant in support of his research. His experiments during World War I were also funded by the U.S. military. The latter resulted in a rocket field weapon, precursor to the bazooka.

Goddard's 1919 Smithsonian report, "A Method of Reaching Extreme Altitudes," established his preeminence in the field. Shortly after its publication, he began experiments using liquid fuels as propellants. In 1924, he married Esther C. Kisk, who helped document his accomplishments via home movies. At his aunt's farm outside Worcester, Goddard launched the first liquid-fuel rocket on 16 March 1926. Subsequent tests drew complaints from neighbors and a desist order in 1929 from the local fire marshal.

National notoriety over the issue attracted the attention of Charles A. Lindbergh, who visited and then supported Goddard. Through Lindbergh, the rocket scientist gained grants (1930–1932; 1934–1942) from the Daniel and Florence Guggenheim Foundation to conduct research near Roswell, New Mexico. In this phase of his career, Goddard created pumps for rocket propellants, techniques for using rocket fuel to cool reaction motors, and guidance systems by employing gyroscopes and deflector vanes. He published a second Smithsonian report, "Liquid-Propellant Rocket Developments," in 1936. During World War II, Goddard served as a consultant to the Curtiss-Wright Corporation and directed research on behalf of the U.S. Navy's Bureau of Aeronautics. The latter contributed to the idea of jet-assisted takeoff (JATO) technology—i.e., rocket power—for aircraft. He died from throat cancer in 1945. In 1960, his widow later sold Goddard's 214 rocket-related patents to the National Aeronautics and Space Administration for $1 million.

James K. Libbey

See also

Bureau of Naval Aeronautics; Curtiss-Wright Corporation; National Aeronautics and Space Administration; United States Navy, and Aviation

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German ace Hermann Goering in his World War I uniform. (George M. Watson, Jr.)

Goering, Hermann (1893–1946)

Second in importance only to Adolf Hitler in the foundation and government of the Third Reich. Goering was a successful fighter pilot in World War I, winning the Pour le Mérite and succeeding Manfred von Richthofen in command of the world's first multisquadron fighter unit, Jagdgeschwader 1 (1st Fighter Wing).

Goering left Germany after the Armistice and upon his 1922 return quickly fell under the influence of Adolf Hitler. Goering was badly injured in the unsuccessful Munich Beer Hall Putsch of November 1923, resulting in a lifelong addiction to morphine and other painkillers. In 1927, he returned from Italian exile to rejoin Hitler and soon became the Nazis' spokesman to the German upper classes. He was elected to the Reichstag as a delegate from Bavaria and in 1932 was chosen its president. After Hitler became chancellor, Goering was named to his cabinet, becoming the Prussian minister of the interior and national commissioner of aviation. He used the former position to cement the Nazis' hold on power by establishing the Gestapo and the concentration-camp system. His second role gave him responsibility for all aspects of German aviation, and when the Luftwaffe was established in March 1935, he became its commander in chief.

In 1936, Goering became the national commissioner for the four-year plan for the German economy. His ruthlessness, energy, and intelligence enabled him to carry out all of his official roles with a high degree of success while participating in the prewar interservice intrigues that ended when Hitler took over direct command of the Wehrmacht.

The September 1939 invasion of Poland ended Germany's string of bloodless territorial acquisitions, and the subsequent declarations of war by Britain and France took Goering completely by surprise; he had believed Hitler's statement that no major war would begin until 1942. Within four years of its official formation, the Luftwaffe had become one of the world's largest, best-organized, and best-equipped air forces, but one that was extremely thin in infrastructure and talent. Goering took full credit for its early successes, and Hitler promoted him to a unique high rank, *Reichsmarschall*, and awarded him a unique medal, the Great Cross of the Iron Cross.

But in the summer of 1940, the Luftwaffe failed to win the quick air victory over England that Goering had promised Hitler. Goering blamed his pilots for this failure rather than taking responsibility for any deficiencies in planning or equipment, and he withdrew almost completely from active command of "his" Luftwaffe, leaving this to deputy Erhard Milch and to the Luftwaffe Chief of Staff, Hans Jeschonnek. He remained active in his role as commissioner of the German economy during the invasion of the Soviet Union in mid-1941, approving plans to loot Ukraine and Byelorussia, starve most of the Slavic inhabitants of the region, and exterminate its Jews.

In early 1943, Goering's broken promise to the Führer—to maintain the Sixth Army at Stalingrad by aerial supply—cost him the last of his credibility, and he spent most of the last two years of the war at his various estates, hunting and admiring his looted art collection. He made only token appearances at Hitler's staff meetings, and most of his infrequent requests were vetoed or ignored.

In April 1945, after Hitler announced his intention to fight to the last in Berlin, Goering radioed Hitler to inquire if this meant that Goering was to take over the government. An enraged Hitler ordered Goering arrested and stripped him of all his duties, turning the Luftwaffe over to General Robert Ritter von Greim. Goering spent the remaining few days of the war under SS house arrest and turned himself over to the U.S. Army on 8 May.

Goering, the highest-ranking German prisoner of war, became the principal defendant in the 1945–1946 Nuremberg war-crimes trials. Unclouded by drugs for the first time in 20 years, his intelligence and arrogance reasserted themselves, and his aggressive, forceful defense dominated the proceedings. Found guilty and condemned to death by hanging, he committed suicide the night before his scheduled execution by swallowing cyanide.

Donald Caldwell

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Golovanov, Aleksandr (1904–1975)

World War II Soviet bomber commander. Aleksandr Evgenevich Golovanov was born on 7 August 1904 in Nizhnii Novgorod, Russia. Following the 1917 revolution, he fought in the civil war and then worked for the security police. In 1933, he completed pilot training and was assigned to Aeroflot, flying long-range aircraft. He spent the 1930s flying prominent political prisoners between Moscow and the Gulag. In 1941, he organized the first bomber regiment to specialize in long-range night-flying. A favorite of Stalin and a sycophant, he was promoted in March 1942 to general and given command of Long Range Aviation (redesignated the Eighteenth Air Army in December 1944) and reported directly to the Supreme High Command. He held that position until 1947, when he was assigned other command duties. After Stalin's death in 1953, Golovanov was retired from the air force. He died on 22 September 1975.

George M. Mellinger

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GOMORRAH (1943)

Allied code name for six air raids on Hamburg, Germany, in mid-1943. This city was chosen for its large size, proximity to the coast, easy identification from the air, and production of U-boats, warships, and aircraft.

The first RAF raid on 24 July involved 791 aircraft and employed Window (air-dropped metal strips) to baffle Ger-

Notorious for the raids in which they were used, the German Gotha aircraft were capable of firing on targets below them, taking the British by surprise. (Smithsonian Institution)

man radar. The attack caused severe damage, and only 12 planes were lost. The Americans struck twice in the next two days and suffered heavy losses. Smoke from the RAF raid impeded the U.S. attacks, but the U-boat yards were damaged.

The RAF returned on 26 July with 787 planes. The Pathfinder force (which marked targets for the following bombers) was exceptionally accurate, and 45 percent of the bombs fell within 3 miles of the aimpoint. Most of the bombs were incendiary, and weather conditions resulted in the first firestorm—one huge, extremely hot fire—that killed more than 40,000 people.

The next RAF raid—777 aircraft on 28 July—focused on areas unharmed by the firestorm. The final raid—737 aircraft on 2 August—was scattered by bad weather and achieved little. In total, Bomber Command launched 3,091 sorties, dropped 8,344 tons of bombs, and lost only 100 planes. Hamburg's industries lost 1.8 months of production and 26–27 U-boats.

The Germans were initially panicked but soon adopted new defensive tactics to counter Window. Other German cities of comparable importance were too far inland and too well defended, and thus the Allies could not repeat their Hamburg performance in many other cities in rapid succession.

James D. Perry

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Gotha Bombers

German World War I–era bomber. In the language of World War I, the word "Gotha"—much like the word "Zeppelin"—described not only an aircraft type but also the raids on which Gotha bombers were used. In the summer of 1917, then, it was not sufficient to say the Germans had attacked London; one had to add whether it was a "Zeppelin raid" or a "Gotha raid." As it happened, if the raid involved airplanes, rather than airships, the Germans might have employed any of several types, *Friedrichshafens, Riesenflugzeugen,* or Gothas, but to the British upon whom the bombs fell they were all Gothas.

The principal Gotha types were the G IV and G V, the "G" standing for *Grossflugzeug,* or large aircraft, the German classification for twin-engine bombers. The aircraft spanned 77 feet, 9 inches, were 38 feet, 11 inches long, and stood 14 feet, 1 inch in height. Powered by twin Mercedes engines, they carried a crew of three and a bombload ranging from 660 to 1,100 pounds.

For defense, the Gotha had two Parabellum machine guns, one in the nose, the other in the tail. The fuselage contained a plywood tunnel that allowed the rear gunner to fire his weapon downward at fighters attacking from below, a feature that early British defenders learned about the hard way. But the Gotha's primary protection, at least in its early days, was its high ceiling—21,320 feet—which put it out of reach of the fairly obsolescent types that flew home defense during 1917. When the British began operating more capable aircraft, the Gotha stopped coming during daylight hours and switched to nighttime raids.

Like other attempts at strategic bombing during World War I, the Gotha raids' principal value was not the damage done but the precious resources that defending against them diverted from the front.

In addition to its heavy bombers, Gothaer Waggonfabrik (the Gotha factory) also manufactured a line of seaplanes. The most famous was the WD (water biplane) 14. The WD 14 was originally used as a *wasser doppeldecker* (biplane seaplane) torpedo-bomber, but it suffered from the same deficiency that hampered most World War I experiments with that type. It lacked the power necessary to lift a really effective load off the water. When attacks against enemy shipping proved unimpressive, the WD 14 was modified for use in long-range reconnaissance, its partially faired torpedo bay being converted to a fuel tank.

James Streckfuss

See also

Airships; Independent Bombing Force

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Great Britain, Missile Development and Production in

The United Kingdom's guided weapons industry had its origins in a number of early experiments conducted during World War II by various establishments. Progress in this work was assisted by an agreement on the transfer of classified U.S. weapons design data that was the result of the Tizard Mission, which visited Washington in 1940.

The first formal staff requirement for guided weapons issued by the Admiralty Signals Establishment in late 1943 proposed a surface-to-air missile (SAM) that would be guided by a radar beam. The Guided Anti-Aircraft Projectile Committee, an interservice committee, was formed in March 1944 to control and direct antiaircraft projectile research. The operational requirements of the army's Anti-Aircraft Command (later transferred to the RAF) and the Admiralty were sufficiently compatible to be jointly investigated, and preliminary work eventually gave rise to the Sea Slug, Bloodhound, and Thunderbird missile systems. Toward the end of hostilities, the Tizard Agreement was reviewed by the United States and the flow of new scientific information was curtailed. This had a serious effect on the progress of British guided weapons development.

By the end of World War II, the British economy was on the verge of collapse and the sudden termination of Lend-Lease forced an immediate reappraisal of substantial defense spending. The Chiefs of Staff made the assumption that there would be no war for the next 10 years. Yet a number of guided weapons research projects were initiated. In the light of the perceived threat from atomic weapons and the realization that the densely populated country might not be capable of surviving a nuclear conflict, priority was given to Fighter Command and antiaircraft defense. In 1948, the Ministry of Supply decided to curtail research into long-range missiles to concentrate on the defensive missile program.

In January 1950, the U.S.-U.K. transfer of guided weapons technology was formalized by the Burns-Templer Agreement, which provided for the full and frank interchange of military information and guided weapons technology. The first batch of information on new U.S. weapons projects arrived during the second half of 1950, and weapons such as the Terrier II, Hawk, and Sparrow missiles were assessed to determine whether they could be accommodated within the U.K. guided weapons program.

The outbreak of the Korean War in June 1950 came as an unpleasant surprise to strategic planners. A drastic rearmament program was initiated, and the defense budget was approximately doubled, assisted by U.S. aid. Although this was a prudent precaution in the light of international events, it exerted a strain on the economy that would have unfortunate consequences before the end of the decade.

In 1955, Sir Anthony Eden initiated a wide-ranging review of defense strategy with a view toward reducing defense spending. Duncan Sandys continued the review through 1957, when a famous white paper on defense was published. It placed great emphasis on the nuclear deterrent, initially delivered by V-bombers and later by the Blue Streak missile fired from underground silos. V-bomber bases were to be protected initially by fighter defenses and later solely by a surface-to-air missiles system. This doctrine was discredited within a few years as it became clear that Britain could not afford to pay for the research and technology necessary to make the deterrent sufficiently safe from attack.

In the late 1950s, the projects that had been initiated in the 1940s began to enter service. The Fairey Fireflash was the first air-to-air guided weapon to be deployed by the RAF, albeit on a very limited scale in August 1957. The Fireflash was a radar beam–rider and had a limited capability against piston-engine bombers.

The first fully operational guided weapon to be deployed was the Bristol Bloodhound SAM, in 1958. It used semiactive Doppler radar guidance and was typically deployed with four mobile launchers controlled by target-illuminating radar. An improved Bloodhound Mk.II entered service in 1964. The Thunderbird SAM debuted with the British army in 1960 and had a similar performance to the Bloodhound.

The first effective air-to-air missile was the de Havilland Firestreak. It was a rear-aspect weapon and was deployed by the Royal Navy and RAF in August 1958. The later Red Top was based on the Firestreak Mk.IV. It was faster, had a longer range, and was capable of all-aspect homing against supersonic targets. It entered service in 1964.

The Armstrong-Whitworth Sea Slug was a naval SAM. Guidance was by radar beam, and it had solid fuel strap-on boosters and a solid fuel sustainer. It entered service in 1962 aboard County-class destroyers after a protracted development period.

The Avro Blue Steel nuclear missile entered service in December 1962 and was carried by Vulcan and Victor V-bombers. It was designed to deliver a nuclear warhead to a target 100 miles from launch using inertial guidance.

The de Havilland Blue Streak was intended to be an intermediate-range ballistic missile. Development relied heavily on U.S. assistance, as the design was based on the Atlas. Following extreme pressure from the treasury, the Blue Streak program was canceled in April 1960 in favor of the U.S. Skybolt missile (which was subsequently canceled by U.S. Defense Secretary Robert McNamara in November 1962).

In 1977, a long period of industrial amalgamation concluded with the formation of British Aerospace (BAe), a large entity that included every remaining British aerospace company with the exception of Short.

The BAe Skyflash missile was the only successful radar-guided air-to-air missile to enter service in the twentieth century and was an adaptation of the Raytheon AIM-7E2 Sparrow with a new monopulse semiactive seeker. It entered service with the RAF in 1980.

Many other missile systems were developed and entered service between the late 1960s and 1980s, including the Sea Dart naval SAM (1967), the Sea Wolf naval SAM (1979), the land-based point-defense Rapier (1970), and the antiship Sea Skua (1982). All of these weapons were used during the Falklands War of 1982 with reasonable success.

In 1996, BAe Dynamics and Matra Defense joined forces to create a new defense company. Matra BAe Dynamics has an extensive and very capable product portfolio and research capability and at the turn of the century is developing the Storm Shadow conventional stand-off missile and the Meteor beyond-visual-range air-to-air missile for the RAF.

Andy Blackburn

See also

Missiles, Air-to-Air; Missiles, Intermediate-Range Ballistic; Missiles, Surface-to-Air

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Greece

Site of protracted World War II air campaign in support of ground operations. On 28 October 1940, Italy invaded northwestern Greece from Albania, well supported by aircraft and expecting a quick victory.

The Elleniki Vassiliki Aeroporia (Royal Hellenic Air Force) was armed with the Polish-built PZL P.24 fighter and a mixed variety of light bombers, liaison, and reconnaissance aircraft. The RAF soon established bases in Greece, and British Gladiator fighters and Blenheim bombers began flying missions on the Epirus front. British Wellington medium bombers also flew in support from bases in Egypt, bombing ports in Albania. It was against Italians flying from Albania that the RAF's highest-scoring ace, South African Marmaduke St. John Pattle, in a Gladiator, scored most of his 40-plus victories.

The Italian air force maintained a steady presence over the front in spite of losses and bad Greek winter weather, and mounted several raids on Athens. An Italian offensive in March met with heavy air losses.

Otherwise something of a sideshow, the Greco-Italian War took on increased importance because of airpower. If the war in the Balkans continued and British involvement increased, British bombers based in Greece and Crete could threaten the vital German oil installations at Ploesti. This fact and the threat of an Allied force operating on the flank of the German armies, which would soon invade the Soviet Union, led Germany to take an active role in the theater. German forces started moving into Romania and Bulgaria in March. The Allies responded with Australian, New Zealander, and British ground forces.

On 6 April 1941, Germany intervened in the Balkan conflict by invading Yugoslavia and moving into Greece through southern Yugoslavia and directly from Bulgaria. More than 1,200 aircraft of General Alexander Löhr's Luftflotte 4 (Fourth Air Force) supported the attack. The complexion of the conflict changed completely.

The Yugoslav air force was quickly eliminated and German bombers made a devastating attack on Belgrade. Yugoslavia signed an armistice on 17 April.

The small RAF contingent, commanded by Air Vice Marshal J. H. D'Albiac, and the remainder of the Greek air force were quickly swept from the skies. Squadron Leader Pattle was shot down and killed on 20 April. The Allied army in Greece fought a series of delaying actions as they withdrew down the peninsula, harried by the Luftwaffe.

In Piraeus Harbor near Athens, German aircraft destroyed the ammunition ship *Clan Fraser,* and secondary explosions closed this important port. As a result, Commonwealth troops were forced to use beaches and small harbors of the Peloponesus for their evacuation. German airborne troops attempted to capture the vital bridge over the Corinth Canal but were unsuccessful. The last RAF aircraft departed Greece on 24 April, and the last of the 50,000 Allied troops to evacuate left by 29 April. Axis operations against Crete followed.

Frank E. Watson

See also
Crete, Battle of

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Greek Air Force

Greek mythology tells of Daedelus and Icarus, a father and son who escaped tyranny by making wings of feathers and wax and flying off their island prison to the Greek mainland. Greek aviators honor those roots and carry on that tradition.

In 1910, the Hellenic government visited France to witness aerial exhibitions and to consider purchasing aircraft. Immediately upon their return they announced that Greece would send officers to France to learn aviation. Although 60 officers applied, only three were chosen. Several months later, three more joined them at the Farman school at Etampes. These six men became the pioneers of military aviation within Greece. The men obtained first their civil, then their military licenses. When they returned a year later to assist in the Balkans conflict, they brought with them Greece's first military aircraft. By May 1912, Dimitrios Kamperos flew the first military aircraft in Greece, a Henri Farman, participating in army maneuvers. During this flight Prime Minister Eleftherios Venezelos joined him as the first passenger in Greece. The prime minister was a great supporter of military aviation and through his example helped assuage the superstitions and fears of a skeptical public.

The first combat air unit of the Royal Hellenic Army was established at Larissa in September 1912. This unit consisted of four Farman biplanes and four officer-pilots. The unit was one of the world's earliest aggressive air forces, preferring to act rather than merely observe. During the Balkan wars in October 1912, the aviators dropped improvised bombs on enemy positions and brought supplies to besieged cities. In January 1913, the first naval air operations began over the Dardanelles. First Lieutenant Michael Moutousis and Ensign Aristidis Moraitinis dropped four bombs on the Turkish fleet from their Farman-adapted hydroplane.

Kamperos envisioned a separate naval air force and adapted one of the Farmans into a hydroplane in June 1912, christening the craft *Daedelus.* Because of the work of Kamperos and Moraitinis, the first Greek naval air force school began in 1914. Despite limited funds, Moraitinis established the Naval Air Force School and Corps in 1914. Moraitinis also established the first aircraft factory, which became the forerunner of the Hellenic aerospace industry. Unfortunately, jealousy over Moraitinis's success induced Kamberos to desert the dream of Greek naval aviation. In 1916, his bid for a separate army air force was supported, which brought the end of naval aviation in Greece.

The Hellenic Army Air Force was established in 1917. During World War I, naval aviation units were also formed. The air force fought valiantly when Italy invaded in 1941. After the war, it became an important part of NATO's strength. The independent air force is now called Polemiki Aeroporia (the Greek air force). The force is divided into three commands: tactical, air support, and air training.

Wendy Coble

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Greim, Robert Ritter von (1892–1945)

The last commander in chief of the Luftwaffe. An outstanding fighter pilot in World War I, during which he won the Pour le Mérite, von Greim had a successful career in civil aviation before rejoining the German armed forces in 1934. He was named the first commander of the first fighter squadron of the new Luftwaffe. During World War II, he was given successively more responsible field commands and higher decorations and gained a reputation as an inspirational leader. Von Greim was the last general promoted to field marshal by Hitler. This took place in a bizarre *Führerbunker* ceremony in besieged Berlin, to which von Greim had been summoned at great personal risk to be told that he was to replace Hermann Goering as Luftwaffe commander in chief. An ardent Nazi to the end, von Greim committed suicide on 24 May 1945 while in U.S. captivity.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Grizodubova, Valentina Stepanova (1910–1993)

The only woman commander of a wing of Soviet airmen. Grizodubova had flown an ANT-37 from Moscow to the Pacific nonstop (6,450 kilometers) on 24–25 September 1938. For this pioneering flight, she became a Hero of the Soviet Union, along with copilot Polina Osipenko (1907–1939) and navigator Marina Raskova (1912–1943), the first Soviet women to be thus honored.

Born in Kharkiv, she graduated from the Penza Flying Club (1929), Kharkiv Flying School, and Advanced Flying School in Tula (1933). Grizodubova flew many types of aircraft, setting seven world records.

In May 1942, she was appointed commanding officer of the 101st Long-Range Air Regiment (renamed 31st Krasnoselsky Guards Bomber Regiment in 1944), where she demonstrated the suitability of her Li 2 (a modified DC-3) for use as a night-bomber. In June 1942, she led her unit in delivering supplies to blockaded Leningrad. She was noted for flying more than her male colleagues did and flew at times as copilot to monitor her pilots' performance. Due to her intervention a troublesome general—her superior—was demoted.

In September 1942, her unit was placed at the disposal of Central Partisan HQ. Overcoming dense enemy flak and engaging enemy fighters, her aircrews flew more than 1,850 supply missions and on their way back evacuated wounded partisans and children. In 1943, she successfully resisted her superiors' orders to decrease these flights.

She flew about 200 wartime missions and overall spent 18,000 hours in the air and was awarded many prestigious military decorations. A senior official of civil aviation, after the war she served on the executive of several veterans' organizations. More unusual, as a member of the Supreme Soviet she courageously criticized Stalin's reign of terror.

Kazimiera J. Cottam

See also
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Groves, Leslie Richard (1896–1970)

U.S. general who played an important role in the development of the atomic bomb. Leslie Richard Groves was born in Albany, New York, on 17 August 1896. He attended the University of Washington for one year and the Massachusetts Institute of Technology for two years before entering the U.S. Military Academy. He graduated in June 1918 and became a second lieutenant of engineers. From 1918 to 1921, Groves took courses at the Engineer's School at Camp Humphreys (today Fort Belvoir), Virginia, with a brief stint in France during World War I. During the 1920s, he had assignments in places such as San Francisco, Delaware, Hawaii, and Nicaragua.

In 1931, Groves went to the Office of the Chief of Engineers in Washington, D.C., where in October 1934 he was promoted to captain. Groves graduated from the Army Command and General Staff School in Fort Leavenworth, Kansas, in 1936 and the Army War College in 1939. In 1939, he was assigned to the General Staff in Washington.

Assigned to the Office of the Quartermaster General in 1940, Groves was promoted to major in July. Later, he returned to the Office of Chief of Engineers as deputy chief of construction and was promoted to temporary colonel in November. He oversaw several projects, including the construction of the Pentagon.

In September 1942, he was promoted to temporary brigadier general and placed in charge of the Manhattan District Engineering Project. Best known as the Manhattan Project, it was the code name for the production of three atomic bombs. Groves was an aggressive manager and an involved leader. Most of the research was done at Columbia University and the University of Chicago by world-famous physicists, including Groves's assistant, J. Robert Oppenheimer, of the University of California and the California Institute of Technology.

Project plants were established in remote parts of the United States to assure secrecy. These included Clinton Laboratory in Oak Ridge, Tennessee, the Hanford Engineering Works near Pasco, Washington, and Oppenheimer's converted summer camp near Los Alamos, New Mexico. Oak Ridge scientists gathered U-235 uranium to form a nuclear chain reaction while their Hanford colleagues made artificial plutonium detonators. At Los Alamos, Oppenheimer's team fashioned the components into three bombs, each able to fit into a B-29 of the 509th Composite Wing.

The project cost $2 billion, most of which came from blind appropriations. The money was spent on the secret purchase and delicate transport of scarce materials, the careful hiring of the workforce (125,000 at its height), and the construction of the worksites. All of this was done under tight security. Perhaps Groves's greatest success was dealing with the many scientists and technicians who were not used to such security.

The project culminated on 16 July 1945, with the detonation of the first device at Trinity Site, Alamogordo, New Mexico. Afterward, President Harry Truman okayed its use on Japan. On 6 August 1945, Colonel Paul W. Tibbets dropped a gun-type device (Little Boy) from the B-29 *Enola Gay* flying at 31,600 feet and destroyed Hiroshima, Japan. Three days later, Major Charles W. Sweeney aboard *Bock's Car* dropped an implosion bomb (code-named "Fat Man") on Nagasaki with equal devastation. As a result Japan surrendered, ending World War II.

Promoted to temporary major general in October 1944, Groves's role in the project cannot be overstated. The confidence U.S. leaders had in his command skills are mirrored by the fact that he remained in charge of U.S. atomic energy development until January 1947. He was then made chief of the Army's Special Weapons Project and promoted to temporary lieutenant general in January 1948.

Groves retired on 1 March 1948 and spent the next 13 years as vice president of Sperry Rand Corporation. He died on 13 July 1970 and was buried in Arlington National Cemetery.

William Head

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Grumman A-6E Intruder

Twin-engine all-weather two-seat subsonic carrier-based attack aircraft. In spite of its 60,400-pound maximum gross weight, it has excellent slow-flying capabilities with full-span slats and flaps. The crew—a pilot and bombardier-navigator sitting side by side—can see in all directions through a broad canopy. The aircraft is equipped with a microminiaturized digital computer, a solid-state weapons-release system, and a single integrated track-and-search radar. The Intruder is armed with laser-guided weapons and equipped with a chin turret containing a forward-looking infrared system and laser designator and receiver.

In 1956, the U.S. Navy requested a carrier-borne all-weather attack aircraft. In size it was to be bigger than the A-4 Skyhawk but smaller than the A-3 Sky Warrior. The requirement also emphasized the ability to fly a long-range mission at low altitude and be capable of performing its mission in bad weather. The aircraft must also be capable of navigating through terrain without help of external sources such as beacons. The A-6E met those requirements.

The A-6 flew round the clock in Vietnam, conducting attacks on targets with pinpoint accuracy unavailable through any other aircraft at that time.

The A-6E proved that it is the best all-weather precision bomber in the world in the joint strike on Libyan terrorist-related targets in 1986. A-6s were used extensively during Operation DESERT STORM, providing precision bombing on a wide range of targets.

Henry M. Holden

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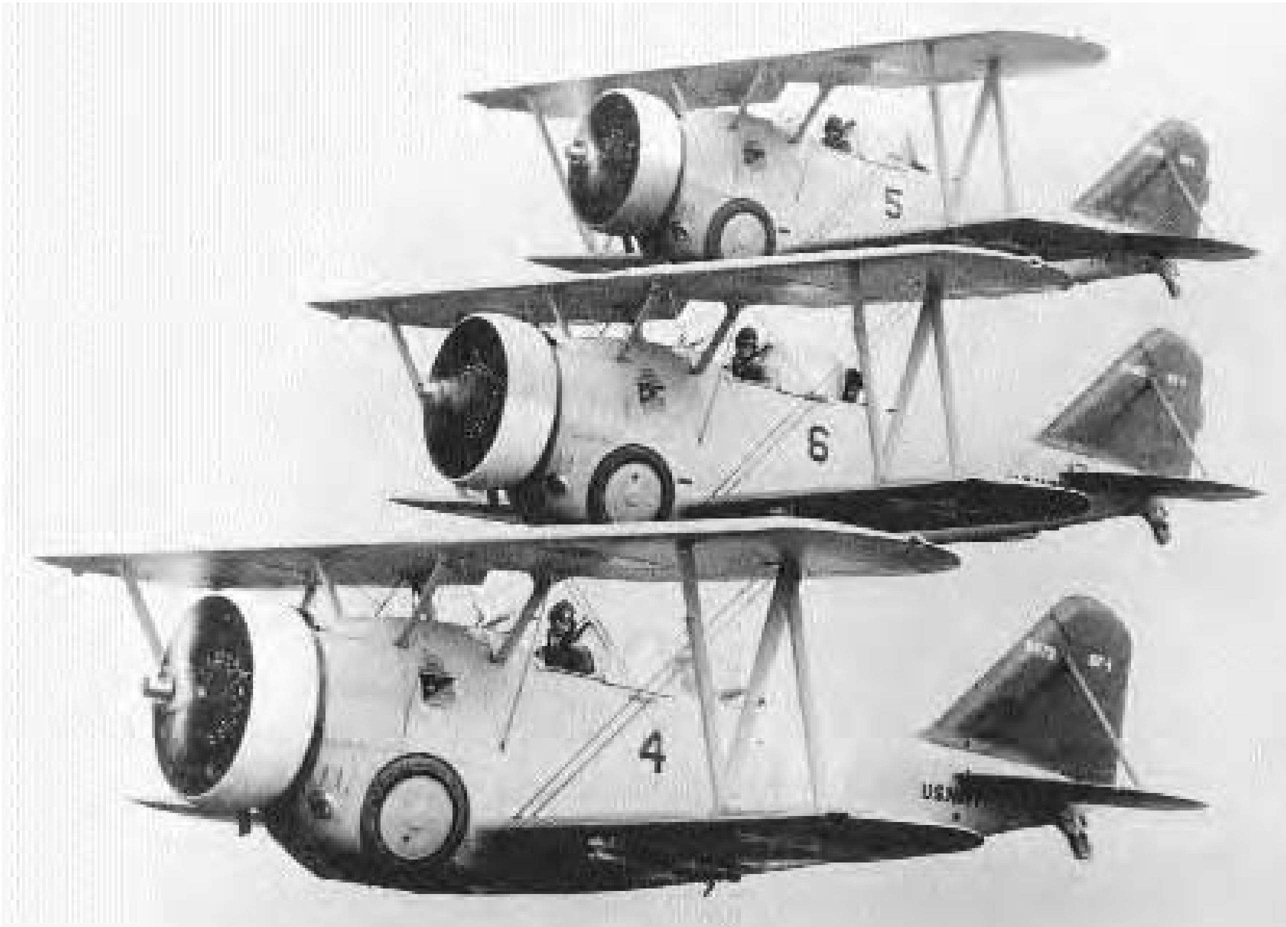
Grumman Aircraft

U.S. aircraft manufacturer. Leroy Grumman and partners William T. Schwendler, Ed Poor, E. Clint Towl, and Leon A.



The two-seat Grumman SF-1 was faster than any Navy single-seat fighter, thanks to its clean design and manually retractable landing gear. (U.S. Navy)

Swirbul founded the Grumman Aircraft Engineering Corporation in December 1929. Grumman and his partners had worked for Loening Aircraft Engineering Corporation when Keystone Aircraft Corporation bought it out. The decision was made to move the operation from New York to Pennsylvania. Grumman and his partners decided to stay in New York and start their own company. They acquired a small garage on Long Island and opened for business in January 1930.

Shortly thereafter, Grumman was contracted by Vought Aircraft to build floats for their Navy Scout planes. With that success, Grumman began work on a design for a fighter aircraft, the FF-1, a leap forward in technology. An enclosed cockpit and retractable landing gear made it unique for its time. Over the course of the next four years, Grumman would move to three new facilities for additional production and development space. The final move was to Bethpage, Long Island.

Grumman's success in producing biplanes (F2F and F3F) and Amphibians (JF and J2F Duck) continued through the mid-1930s, when its attention turned to monoplane fighters. In 1937, Grumman competed against Brewster for the right to produce the U.S. Navy's first monoplane fighter. The Brewster F2A Buffalo won the competition, but not the trust of the U.S. Navy, and Grumman was asked to continue work on its F4F Wildcat. The Wildcat's performance was determined to be superior to the Buffalo's, and an order was taken for 54 Wildcats. It would go on to become immensely popular with pilots and effective in the Pacific against the Japanese during World War II.

The Navy Wildcat would eventually be replaced by one of Grumman's own designs, the F6F Hellcat. Speed, maneuverability, and durability would make the Hellcat America's top ace-maker. Its performance in the Pacific brought its pilots an impressive 19:1 favorable kill ratio.

Grumman also was asked to design a Navy torpedo-bomber, the TBF Avenger. Again, Grumman put forth a simple but rugged design that would serve its crewmen well. The Avenger took part in the sinking of 12 Japanese aircraft carriers, six battleships, and nineteen cruisers during World

No sight was sweeter to a downed airman than that of a Grumman HU-16 Albatross on its way in for a pickup. (U.S. Air Force)

War II. In 1942, Grumman turned over production of Avengers and Wildcats to the Eastern Aircraft Division of General Motors so it could concentrate on the development and production of the Hellcat at the Bethpage facility.

After World War II, Grumman continued to produce aircraft. During the Korean conflict, Grumman developed the F9F Panther for the U.S. Navy. In Vietnam, the A-6 Intruder was used by the Navy and Marines. Finally, Grumman produced the F-14 during the close of the Vietnam War. This aircraft is still in service today. Grumman also expanded its scope to the aerospace industry, working with NASA on the Lunar Module that would help land the first man on the moon in the 1960s.

Grumman was bought out by Northrop in 1994 and operates today as Northrop Grumman.

David A. Pluth

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Grumman Biplane Fighters

American aircraft series that began with the FF-1, FF-2, SF-1, and GG-1. Beginning operations in December 1929, the Grumman Corporation's first products were monocoque aluminum floats for observation floatplanes, designed with retractable landing gear.

In February 1930, the U.S. Navy asked Grumman if its retractable landing gear mechanism could be adapted to existing fighter aircraft. This motivated Grumman to respond in March to a procurement request for a two-seat fighter, proposing an all-metal (except for fabric wing covering) biplane aircraft with enclosed cockpits as well as retractable landing gear and powered by a Wright R-1820 575-shp Cyclone engine. The estimated performance was greater than any fighter in Navy service; the Navy purchased only drawings to construct a wind-tunnel model. It then ordered one prototype of the fighter in March 1931, designating it XFF-1, which flew on 29 December 1931 and was delivered the same day. It was 7 mph faster than the F4B-4, the fastest Navy fighter at the time. Board of Inspection and Survey flight trials resulted in minor changes, and 27 production aircraft, armed with two forward-firing machine guns and one swiveling gun, all .30-caliber, in the rear cockpit. The first was delivered in April 1933 and the last in November. VF-5B, on the USS *Ranger,* was the only squadron to completely equip with the FF-1, which remained in frontline service until April 1936, being redesignated FF-2, a reversion to the trainer role, the last of which was stricken July 1942. A parallel development, the SF-1, was a scout aircraft using one fewer gun and increased fuel tankage, of which 34 were built, deliveries being from February through July 1934. Only one squadron (VS3B) was completely equipped with SF-1s, and they were removed from front-line service in mid-1935. Other squadrons used single examples of both the FF and SF aircraft.

In 1934, Grumman built a single GG-1 (Grumman G-23) for use as a company demonstrator for export sales. It initially was powered by an R-1340 but was later reengined with an R-1820 of 890 hp, giving it a top speed of 242 mph. Canadian Car and Foundry obtained a license and produced 52 aircraft (having built components for 70) and sold one to Japan, one to Nicaragua, and 50 initially to Spain (erroneously thinking that they were for Turkey). The last 16 of these were taken over by the Canadian Air Force. The ones remaining in Spanish service were scrapped in 1955.

In the fall of 1932, Grumman proposed a new single-seat biplane fighter to the Navy, which had decided to abandon two-seat fighters. This would lead to the F2F, XSF-2, and XSBF-1. The proposal for the F2F, powered by a twin-row R-1535 of 625 shp, was accepted in November, and the only prototype flew on 9 October 1933. This design featured a watertight compartment beneath the pilot and a variable-incidence tailplane for trimming in flight. Flight trials revealed a top speed of 229 mph and the need for only minor changes. Fifty-four production F2F-1s were ordered in May 1934. The first was delivered in January 1935 and the last in August. They were again the fastest Navy fighters in service. Six squadrons operated F2Fs, and the last was withdrawn in 1942. The last aircraft of the SF-1 order was modified to accept the engine and cowling of the F2F, and in early 1935 Grumman built a single prototype XSBF-1 for a fighter-bomber competition that embodied further improvements to the SF airframe, including F2F and F3F design elements.

In October 1934, Grumman was awarded a contract for a single prototype XF3F-1, an evolutionary improvement of the F2F focusing on stability and retaining the same engine while increasing the length and wingspan. It flew on 20 March 1935 and crashed during dive-tests two days later. A second prototype was ordered and flew on 9 May 1935 and crashed during dive-tests eight days later. A third prototype was ordered and flew on 7 June 1935; it passed trials in March 1936. Fifty-four production F3F-1s were ordered, with the first delivered in January 1936 and the last in September. Armament of the F3F was two .50-caliber machine guns. Four squadrons were equipped with F3F-1s, and the last was withdrawn from squadron service in February 1941.

The F3F-2 received the more powerful R-1820 engine of 865 shp. This was a competitive response to Brewster's being awarded the F2A contract. The F3F-2, using the same engine as the F2A, achieved nearly the same performance. The XF3F-2 was ordered in June 1936 as a modification of the last –1, and flew on 21 July 1936. In March 1937, 81 production F3F-2s were ordered, the first being delivered in July, having a 950-shp Cyclone and other evolutionary improvements. Three new F3F-2s were built in 1993 by the Texas Aircraft Factory for museum and air-show use.

The XF3F-3, ordered in May 1938, was to fill a need resulting from delays in the F2A and F4F programs and featured further minor improvements in the F3F design. It was the last of the biplane Navy fighters ordered. The Cyclone engine had a two-speed supercharger to raise its operating altitude ceiling nearly 5,300 feet, to 30,000 feet. Twenty-seven were built and were used to augment various Navy squadrons. One- and two-seat versions of the F3F were built for Al Williams as the Gulfhawk II and III, and one two-seat demonstrator was built for Grumman's use.

Douglas G. Culy

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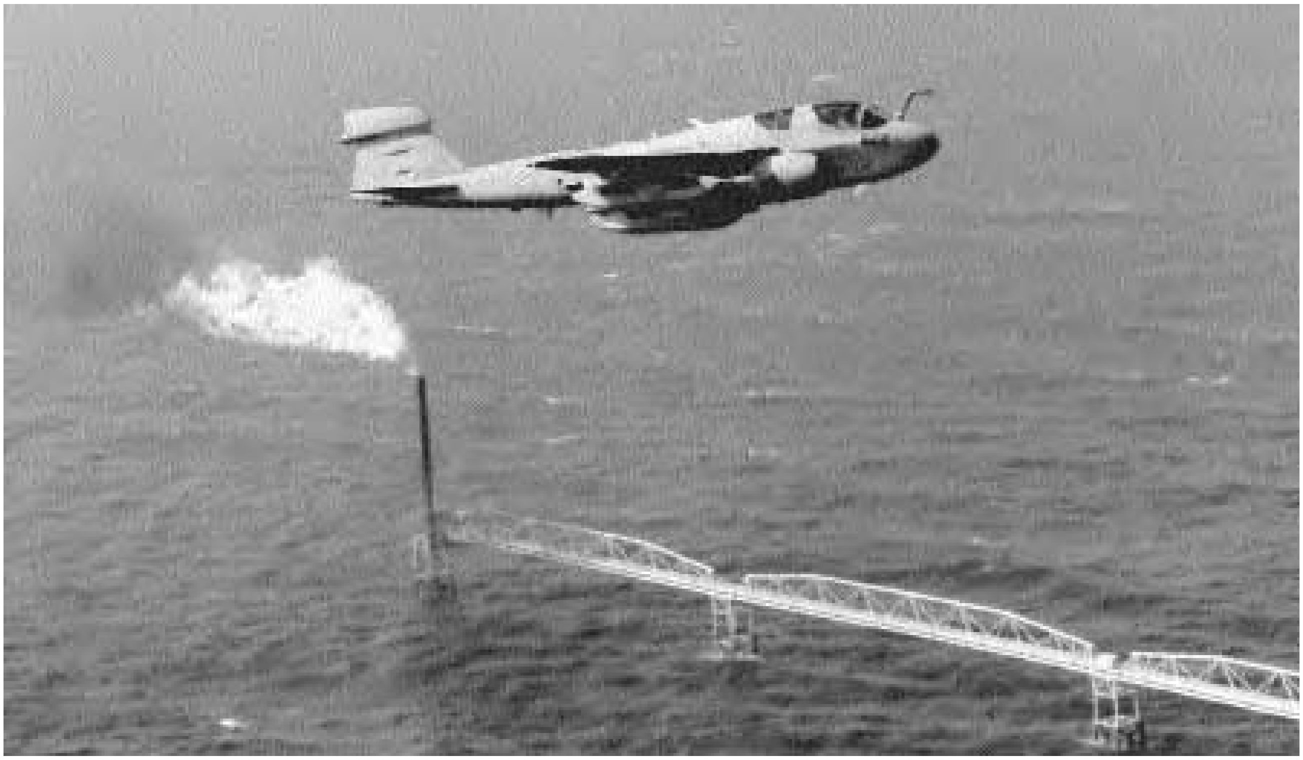
Grumman EA-6B Prowler

Twin-engine midwing aircraft manufactured as a modification of the basic A-6 Intruder airframe. Its first flight was on 25 May 1968, and it became operational in July 1971. Designed for carrier and advanced base operations, the Prowler's primary function is electronic countermeasures. It is a fully integrated electronic warfare system combining long-range all-weather capabilities with advanced electronic countermeasures. A forward equipment bay and pod-shaped faring on the vertical fin house the additional avionics equipment. The side-by-side cockpit arrangement gives maximum efficiency, visibility, and comfort.

Early experiences with the EA-6A led to the development of a lengthened four-seat advanced EA-6B. Instead of two-man crews in the EA-6A, the B variant deploys four-man crews (one pilot and three electronic warfare officers) to manage the sophisticated array of systems.

The EA-6B first saw action in the Vietnam War in July 1972. The EA-6B has gone through many upgrades. The most recent is the ADVCAP configuration. The basic type has a new jammer system and an expanded AN/ALE-39 chaff dispenser. The other will have new displays, radar improvements, and an improved tactical support jamming system and digital autopilot.

Henry M. Holden



The Grumman EA-6B Prowler is one of the most important aircraft in the U.S. inventory, providing electronic countermeasures support for both the Navy and Air Force. (U.S. Navy)

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Grumman F-14 Tomcat

U.S. Navy's primary fleet defense fighter for more than 25 years. The first prototype made its maiden flight on 21 December 1970; unfortunately, the aircraft crashed on its second flight nine days later.

The F-14 was embroiled in controversy almost from the beginning. It was a large, expensive aircraft designed to replace the even more controversial Navy version of the General Dynamics F-111. The Total Procurement Package concept (fixed-price development contract) under which the F-14 was procured almost drove Grumman into bankruptcy. The crash of the first prototype did not help. But in the end the Tomcat developed into a very capable and long-lived aircraft.

A total of 710 aircraft were manufactured, including 80 for the Imperial Iranian Air Force before the fall of the shah. Many are still in service in the year 2000, and recently the F-14 has been fitted for ground attack missions using advanced LANTIRN targeting systems. A TARPS system is also available to selected F-14s and provides the fleet's primary reconnaissance asset.

Dennis R. Jenkins

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Grumman F4F Wildcat

U.S. Navy World War II fighter. Prior to World War II, a competition was held to select the Navy's first monoplane fighter. The Brewster XF2A Buffalo won out based on some engine and instability problems that the Wildcat possessed. The Navy, however, was not satisfied with the performance of the Buffalo and authorized Grumman to continue work on the Wildcat. An order for 54 F4F-3 Wildcats was submitted to Grumman on 8 August 1939. In October 1939, France submitted an order for 100 aircraft. This order was diverted to England when France was taken over by Germany. In British service, the Wildcat would become the Martlet I. On 25 December 1940, it would become the first of the F4F line

The swept-back wings of these Grumman F-14 Tomcats reveal that they are making a high-speed pass. Complex and not easy to fly, the Tomcat gained its greatest public acclaim in the film Top Gun, *but it was already highly regarded by professionals. (U.S. Navy)*

From its first flight on 21 December 1970, the Grumman F-14 Tomcat has been one of the most advanced aircraft in the world. In the war against terrorism, it has extended its fleet defense role to include reconnaissance and ground assault. (U.S. Navy)

The Grumman F4F Wildcat proved to be a rugged fighter. The Zero could best it in one-on-one combat, but two F4Fs flown together, using the Thach weave, could handle up to four of the enemy. (U.S. Navy)

to score an air victory when a Martlet I shot down a German Ju 88 bomber over Scapa Flow near Scotland.

In December 1940, U.S. Navy squadrons began to receive the Wildcat. The carriers USS *Ranger* and USS *Wasp* received the first shipment. The Wildcat's first service for the United States was in defense of Wake Island, when two shot down three Japanese bombers that were part of a 30-plane raid.

Lieutenant Edward "Butch" O'Hare became the U.S. Navy's first ace on 20 February 1942, shooting down five Japanese bombers that were attacking the USS *Lexington.* Many aces would follow. In all, 34 Marine pilots and 27 Navy pilots would become aces flying the Wildcat. The top-scoring ace was Joe Foss, with 26 air victories, all in Wildcats.

In January 1942, General Motors switched over several factories from producing cars to producing aircraft. Shortly thereafter, the production of the Wildcat was shifted from Grumman in order to allow Grumman continue development of the F6F Hellcat, which would replace the Wildcat.

Although the Wildcat was replaced as a front-line fighter in mid-1943, it did gain distinction as the only U.S. fighter to serve from the bombing of Pearl Harbor through war's end.

David A. Pluth

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Grumman F6F Hellcat

The direct replacement for the F4F Wildcat, the U.S. Navy's frontline carrier fighter in 1942. The Navy's order for the first two prototypes was taken on 30 June 1941. The first prototype flew on 26 June 1942. The first production version of the Hellcat was the F6F-3, which first flew on 4 October 1942 and was carrier-qualified on the USS *Essex* in February 1943.

The Hellcat first saw combat on 31 August 1943 when groups from *Yorktown, Independence,* and *Essex* raided Marcus Island. Its first large air battle was in the Kwajalein-Roi area on 4 December 1943. Ninety-one Hellcats met 50 Japanese Zeros, shooting down a total of 28 while losing only two.

The next major version of the Hellcat, the F6F-5, first flew in April 1944. Production began in April 1944 and continued until November 1945. In all, 12,275 Hellcats were produced for the U.S. Navy, France, England, and even Uruguay.

By war's end, 5,156 enemy planes were shot down by Hellcats, for a 19:1 favorable kill ratio. Hellcat pilots accounted for 4,947 of the 6,477 total aircraft shot down by U.S. Navy pilots. The Hellcat was America's number one ace-maker, with 307 Hellcat pilots claiming the title.

The Hellcat ended its distinguished military career during the Korean War, where it was used as a target drone and drone bomb.

David A. Pluth

Ordered by the British navy to replace the F4F, the Grumman F6F Hellcat had a 19-to-1 kill ratio over all enemy planes. (Philip Makanna)

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Grumman F9F Panther/Cougar

U.S. Navy jet fighter. The Grumman F9F was ordered in April 1946 as a straight-wing fighter using four 1,500-pound/ thrust Westinghouse J30 engines. Grumman quickly decided that it was more efficient to use a single 5,000-pound/ thrust Rolls-Royce Nene—interestingly, the same engines were provided to power the Soviet MiG-15 prototypes.

The straight-wing XF9F-2 made its first flight on 24 November 1947, powered by a British-built Nene. Production models would be equipped, alternately and almost interchangeably, by Pratt and Whitney J42s (F9F-2) or Allison J33s (F9F-3). An improved J33-A-16 powered the F9F-4 while a new Pratt and Whitney J48-P-6 was used in the F9F-5, both distinguished by slightly higher and more pointed vertical stabilizers. A total of 1,388 Panthers were manufactured; at least 715 of them saw service during the Korean War. On 9 November 1950, an F9F-2 became the first Navy jet to shoot down another jet fighter, a swept-wing MiG-15 that also used a version of the same Rolls-Royce engine design.

The successful development of the swept wing caused Grumman to redesign the Panther. Three XF9F-6 prototypes were converted from F9F-5s, renamed Cougar, and first flown on 20 September 1951. The design proved successful, being roughly 50 mph faster than the straight-wing variant. A total of 645 F9F-6 fighters and 70 F9F-6P reconnaissance aircraft were delivered by mid-1954, all using Pratt and Whitney J48-P-8 engines. The Allison J33-A-19 was used in 168 similar F9F-7s. Cougars joined operational squadrons beginning in November 1952, but only 18 were deployed to Korea before hostilities ended.

A longer fuselage, larger wing, and more powerful Pratt and Whitney J48-P-8A engine were incorporated into the F9F-8, first flown on 18 December 1953. Provisions were also incorporated for four Sidewinder air-to-air missiles. Grumman delivered 601 F9F-8s between February 1954 and March 1957, with most of them being modified to the

F9F-8B configuration capable of delivering tactical nuclear weapons. The last Cougars were 110 F9F-8P reconnaissance aircraft and 400 two-seat F9F-8T trainers. The trainer version, later redesignated TF-9J, remained in service until 1974.

Dennis R. Jenkins

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Grumman TBF/TBM Avenger

U.S. Navy World War II torpedo-bomber. In 1939, the U.S. Navy decided that a new torpedo-bomber was required to replace the Douglas TBD Devastator in the U.S. arsenal. Specifications were written, and two companies, Grumman and Vought, entered competition for the contract. Two XTBF-1 prototypes were ordered on 8 April 1940, and Grumman received a contract for 286 TBF-1s in December 1940.

Delivery of the Avenger began in January 1942 to VT-8 (torpedo squadron from the USS *Hornet*). In May, VT-8 headed to Hawaii to board the *Hornet.* The group missed the departing ship by one day. On 1 June, six Avengers were flown to Midway Island. On 4 June, these six Avengers would be the first Avengers in combat against the Japanese fleet at Midway. Five of the six were shot down in the battle while doing little or no damage to the Japanese.

The first carrier-based Avenger attack occurred on 24 August 1942 when two Avengers discovered the Japanese aircraft carrier *Ryujo* during a scouting mission. They dropped their four 500-pound bombs, with none hitting the mark. They did, however, report their findings back to the U.S. carrier *Enterprise,* which launched an attack with Avengers and Dauntlesses. The Avengers carried torpedoes while the Dauntlesses carried bombs. The coordinated attack sank the *Ryujo.*

In November 1942, production of the Avenger shifted to the Eastern Aircraft Division of General Motors with the first TBM (note the designation change) coming off the production line in mid-1943. Grumman ceased production of the Avenger completely by the end of 1943 to concentrate on the Hellcat.

The Avenger had many roles during World War II. In the Atlantic, it was used on escort carriers to protect convoys of troops and supplies headed for Europe. Some 950 Avengers served in the Royal Navy's Fleet Air Arm as the Tarpon (eventually becoming the Avenger I) in various roles from submarine patrol to escort duty.

The Avenger's biggest role of the war, however, was that of attack-bomber. The Avenger took part in sinking 12 of Japan's 26 aircraft carriers, six of 11 battleships, and 19 of 41 cruisers. The Avenger was the U.S. Navy's last torpedo-bomber ever ordered into production, with the role deemed no longer necessary after World War II.

The Avenger remains in service today. It is a very successful firefighting bomber that works to control forest fires in the United States and Canada.

David A. Pluth

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Guadalcanal

The opening U.S. offensive of World War II in the Pacific, the first fought by land, sea, and air. The clash of contending airpowers, in all their manifestations, dominated the campaign. Operation WATCHTOWER's primary objective was control of an air base, Henderson Field, whose construction by Japanese forces precipitated its launch.

Japanese airpower throughout the campaign rested upon the Eleventh Air Fleet at Rabaul. Approximately 50 G4M bombers and an equal number of A6M Zero fighters for escort and base defense formed its core. Small numbers of D3A dive-bombers and a few flying boats supplemented its strength. On Guadalcanal itself, U.S. Marine Corps and Army units with fighters and dive-bombers provided most local support and defense. Army, Navy, and ANZAC aircraft flew long-range offensive and reconnaissance missions from more distant bases.

Pacific Fleet carriers covered the beach landings on 7 August 1942 but withdrew after two days, forcing the transports to depart. Henderson Field was ready to receive Marine Air Group 23, its first aircraft, on 20 August, followed by Army Bell P-400s of the 67th Fighter Squadron two days later and, temporarily, Navy SBD-3s from the *Enterprise* on 24 August. Over the next six months, the Marines deployed to Guadalcanal eight scout-bomber and seven fighter squadrons, the Army six fighter and two bombardment squadrons, supported by reconnaissance aircraft, temporary Navy detachments, and two RNZAF bomber units.

From the operation's outset it was clear that command of the sea would determine its outcome—and that the contest for air superiority would decide that command. Two large-scale carrier actions, the Battles of the Eastern Solomons and Santa Cruz, demonstrated airpower's significance most dramatically. On 24–25 August, and again on 26 October, U.S. Pacific Fleet carriers engaged their Combined Fleet counterparts in tactically indecisive battles that nevertheless achieved the U.S. aim of preventing large-scale reinforcement of Japanese forces on Guadalcanal. On both occasions the Japanese carriers' withdrawal left the transports they were covering vulnerable to devastating attacks, primarily by aircraft from Henderson Field but also from the U.S. fleet.

Dramatic though these battles were, the principal struggle in the air was between contending Japanese and U.S. land-based air forces. This soon became a battle of attrition as each side struggled to replace combat and operational aircraft and aircrew losses sustained in continuous action while attempting to increase their total deployed forces. Eleventh Air Fleet launched almost daily raids, using two dozen or so bombers with fighter escort, losing 15–30 percent of their number to U.S. defenders. By the end of September, more than 200 Japanese aircraft had been lost since the campaign began.

Marine Corps scout-bombers raided Japanese positions on the island, provided close support for the infantry, and scoured a 200-mile radius from Henderson field for enemy shipping. Air raids and accidents, however, took their toll. Despite enjoying a 6:1 victory-to-loss ratio, U.S. fighter strength also diminished rapidly as conditions at Henderson Field took their toll (67th Fighter Squadron's strength, for example, fell from 14 to three aircraft in four days, largely due to operational losses).

By mid-September, several important features of the aerial campaign at Guadalcanal were clear. U.S. air forces ashore had wrested sufficient local control of the air to ensure continued supply and reinforcement of U.S. forces on the island, albeit at a significant cost. Japanese surface forces endeavoring to reinforce their position could operate only during the 12-hour-long tropical nights or risk annihilation from U.S. airpower; their own air forces generally could simultaneously inhibit substantial U.S. offensive surface movement, so both navies became nocturnal combatants. Finally, Japanese airpower was too distant and insufficient to offset its army's numerical inferiority on the island, its navy's inability to land large-scale reinforcements and supplies, and growing U.S. ground, air, and naval strength at Guadalcanal.

By late December it was clear that Japan could not break the U.S. hold on Guadalcanal. Even its navy's reinforcement missions became perilous as night-flying radar-equipped PBY flying boats began directing torpedo-boats and destroyers against them. Nevertheless, the Imperial Japanese Navy was able to pull off one final success in the face of U.S. airpower: the evacuation, with relatively little loss, of its surviving garrison from the island.

Paul E. Fontenoy

See also

Eastern Solomons, Battle of; Halsey, William F.; Japanese Naval Air Force, Imperial; McCain, John S.; Santa Cruz, Battle of; U.S. Marine Corps Aviation

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Guam, Battles of (1944)

Site of air operations to support of U.S. amphibious invasion. Japanese forces occupied U.S.-owned Guam, in the Mariana Islands, on 10 December 1941.

In 1944, the Allies moved against the Marianas. U.S. Marines landed on Saipan on 15 June, but after the approach of the main Japanese fleet was detected, Admiral Raymond A. Spruance called off landings on Guam and dispersed the transport fleet until the Japanese had been defeated in the Battle of the Philippine Sea. After the delay, landings by III Amphibious Corps commenced on 21 July 1944, and the island was secure by 10 August. U.S. airpower supported ground operations for the duration of the fighting.

The postponement of the Allied landings on Guam showed the importance that Japanese carrier-based airpower still held in U.S. naval operations as late as mid-1944.

Frank E. Watson

Guernica

Site of air attack during the Spanish civil war. In 1931, Spain became a constitutional republic with much opposition from conservatives, who wanted a return to monarchy. In Catalonia and the Basque region, separatists desired to form their own government. When the Republicans won the election of 1936, a conspiracy of generals supported the rebellion of Francisco Franco and fascism.

The civil war lasted for three years. Adolf Hitler's Germany and Benito Mussolini's Italy sent troops and aircraft to the Nationalists. Stalin's Russia sold supplies, including aircraft, to the Loyalists. Britain and France stayed officially neutral, but their citizens flocked to the Republican cause.

In early 1937, after the first months of fighting had given

A direct descendant of the German Wasserfall missile, the Soviet Union's SA-2 Guideline was one of the most important surface-to-air missiles ever built. (Lon Nordeen)

neither side a clear advantage, General Emilio Mola led 40,000 troops into the Basque country and threatened to raze Vizcaya if the loyalist Basques did not surrender. Backing his threat was the Kondor Legion of 100 German bombers and fighters.

Mola attacked Guernica, the refugee-flooded traditional center of the Basque region, on market day when the streets were full of people. The Kondor Legion, in a three-hour attack, first dropped incendiaries, then strafed the people. The city was in flames and the dead and wounded (elderly, women, children) were everywhere. This was the most effective air assault that had attempted to destroy a city and its civilian population.

When world opinion became outraged the Nationalists denied responsibility, then claimed that the Basques fired their own city. Pablo Picasso immediately began painting his commemorative masterpiece, which hung at a 1937 international exposition. By 1939, the Nationalists had won the civil war.

John Barnhill

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Guideline (SA-2) Surface-to-Air Missile

The Soviet Union's Lavochkin Design Bureau began developing the SA-2 Guideline in 1952. Testing commenced in 1954, and deployment began in 1957. Many countries (Warsaw Pact nations, China, Cuba, Egypt, Iraq, and Vietnam) acquired the SA-2. Improved and indigenously produced versions are still used today.

Lavochkin designed the SA-2 to defend cities and fixed installations from high-altitude U.S. bombers. SA-2 sites consist of six revetted launch positions surrounding a command post, a Fan Song missile control radar, a Spoon Rest early warning radar, and reload missiles on trailers. All components are road/rail mobile, but setup time is lengthy. The two-stage missile is 10.6 meters long, 0.7 meters wide, and weighs 2,300 kilograms at launch. Maximum range is 35–50 kilometers, maximum altitude is 27–40 kilometers, and maximum velocity is Mach 3.5. The 195-kilogram high-explosive warhead has a 65-meter kill radius, with severe damage at 100–250 meters.

More than 13,000 SA-2s have been fired in combat. SA-2s shot down U-2s over Sverdlovsk in 1960 and over Cuba in 1962. From 1965 to 1972, North Vietnamese SA-2s shot down about 150 U.S. aircraft and forced U.S. pilots to fly lower, where antiaircraft artillery was more effective. Later in the war, jamming and suppression missions kept SAM kill rates low.

James D. Perry

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Gulf of Tonkin Resolution

U.S. Public Law 88–408, which gave President Lyndon Johnson power to take whatever actions he deemed necessary—including the use of armed force—to defend Southeast Asia. This resolution was passed by Congress in reaction to two allegedly unprovoked attacks by North Vietnamese torpedo boats on the U.S. destroyers *Maddox* and *C. Turner Joy* in the Gulf of Tonkin on 2 August and 4 August, respectively.

The resolution passed 82-2 in the Senate, where Democrats Wayne K. Morse of Oregon and Ernest Gruening of Alaska were the only dissenting votes; the bill passed 416-0 in the House of Representatives. President Johnson signed it into law on 10 August. The resolution gave Johnson broad authority to conduct the war in Vietnam. It became the legal basis for every presidential action taken by the Johnson administration during its conduct of the war. Despite the initial support for the resolution, it became controversial as Johnson used it to increase U.S. commitment to the war in Vietnam. Several years later, as the war became even more controversial, President Richard Nixon drew upon the resolution to justify the incursion into Cambodia in April 1970. Many congressmen came to see the resolution as giving the president a blanket power to wage war; it was repealed as of December 1970.

James H. Willbanks

See also

Vietnam War

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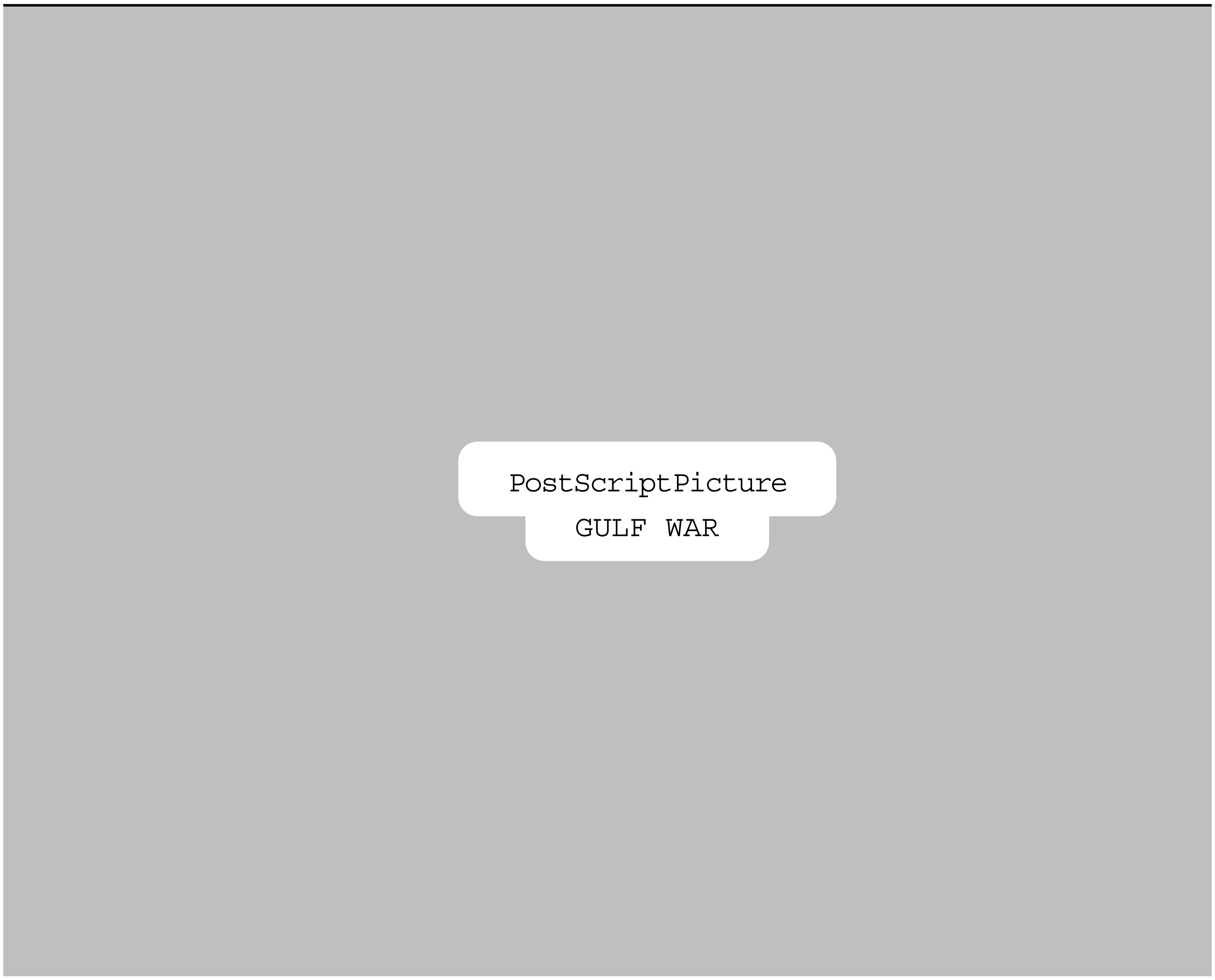
Gulf War (1991)

On 2 August 1990, Iraqi forces under the command of Saddam Hussein invaded and occupied Kuwait, an action that precipitated the Gulf War. Disputes between Kuwait and Iran stemmed from one primary issue: money. Iraq, having financed its recent war with Iran, amassed an $80 billion debt, a portion of which was owed to Kuwait. Iraq also claimed that the Kuwaiti government continued to pump oil from a field along their common border without sharing the revenue and that Kuwait continued to produce more oil than agreed to by OPEC, thereby depressing the price of the commodity, which was Iraq's main export. Within hours the Iraqi forces captured Kuwait City, where all movable assets were confiscated and returned to Iraq. Kuwait's ruling family appealed to the United Nations Security Council and the Arab League for assistance. An embargo against Iraq resulted in Hussein declaring that Kuwait had been annexed on 8 August. An international coalition with troops from Saudi Arabia, the United States, the United Kingdom, France, Egypt, Syria, Senegal, Niger, Morocco, Bangladesh, Pakistan, the United Arab Emirates, Qatar, Oman, and Bahrain assembled forces primarily in Saudi Arabia. Other countries made significant contributions of ships, forces, and medical supplies in support of the Coalition's war against Iraq. When attempts to pressure the Iraqi forces into withdrawing failed, the United Nations passed a resolution allowing for the use of all necessary means to restore the country of Kuwait to its people. The U.S. Congress passed a resolution on 12 January 1991 allowing President George Bush the authority to use force against Iraq.

The expiration of a UN deadline for withdrawal by 12 January 1991 resulted in the commencement of air assaults designed to disrupt command-and-control operations and to weakened the Iraqi forces. The United States Air Force, along with British pilots, dominated the skies over the country. Using precision bombing, the Air Force targeted electrical plants, command centers, roads, bridges, and government structures with a minimum impact on civilians. Bombing continued for five and a half weeks, with more than 100,000 flights by Coalition forces. Iraq responded by attacking Israel with Scud missiles in an attempt to draw Israel into the war, an action calculated to divide the Arab nations from the rest of the Coalition.

The USAF flew more than 65,000 missions with 35 kills against fixed-wing aircraft. Officials utilized a flexible response policy deploying a variety of aircraft to accomplish war goals. Initial attacks on Baghdad required the combined stealth and precision of the F-117 fighter-bomber. Flying 1,300 combat missions and dropping 2,000 tons of bombs within 6,900 hours, these planes achieved air superiority for the Coalition forces. During Operation DESERT SHIELD, prior to the attack on Iraq, the F-15 was deployed as a defensive shield; after fighting broke out it was used to help establish air superiority. Forty-eight F-15Es, utilizing the Joint Altitude Navigation and Attack Radar System, proved effective in locating and destroying Scud missile sites. The deploy-



ment of 144 A-10s resulted in 8,100 missions primarily against tanks. The F-111 targeted military production facilities by utilizing its forward-looking infrared and laser-designation systems. EF-111s and F4-Gs effectively jammed Iraqi radar capabilities. F-16s attacked ground forces in the Kuwaiti Theater of Operations while B-52s dropped 25,700 tons of munitions on airfields and industrial targets within Iraq. AH-64 Apache helicopters, designed to destroy tanks and armored vehicles, and Drones, remote-controlled pilotless planes designed for intelligence-gathering, also operated effectively. By using precision-guided munitions, or smart bombs, the USAF reduced collateral damage to civilian structures as well as civilian casualties. The Maverick missile, used by the F-16s and A-10s, proved its accuracy by destroying one tank for each missile deployed. AIM-7s and AIM-9s proved to be effective air-to-air missiles.

Land forces launched an attack on 24 February, focusing on the Iraqi port of Al Basrah, a maneuver designed to surround Kuwait. Iraqi troops quickly surrendered as the Coalition forces moved rapidly toward Kuwait City. Retreating back to Iraq, Hussein's forces destroyed oil wells by setting them afire, producing an environmental disaster. On 26 February, Iraq announced it was withdrawing from Kuwait. The land war lasted only 100 hours.

After the signing of a cease-fire, the United Nations Security Council outlined necessary measures for lifting the embargo against Iraq, including payment of damages, destruction of all biological and chemical weapons, and international inspection. A secondary issue arose over Iraqi treatment of Kurds within Iraq. Throughout the remainder of the decade, U.S. and British forces repeatedly patrolled a no-fly zone and struck Iraqi missile launch sites. Iraq's role in the terrorist attacks against the United States in September 2001 was unclear at the time, although Saddam Hussein was still suspected of trying to develop weapons of mass destruction.

Cynthia Clark Northrup

The Boeing air-launched cruise missile gave a standoff capability to the venerable Boeing B-52 bomber in the Gulf War. (Walter J. Boyne)

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Gun Sights

Devices that allow a pilot or gunner to aim weapons at an enemy aircraft. Air-to-air gunnery entails hitting a moving target with projectiles that are constantly decelerating and subject to gravity and are fired from a platform that is also moving. The pilot or gunner must aim ahead of the target by some angle (the deflection angle) and allow for gravity drop, wind, and the like so that bullets and target arrive at the same point simultaneously.

The problem reduces as muzzle velocity increases and as range reduces. Many aces (e.g., Erich Hartmann) closed to pointblank range before firing in order to reduce deflection to a minimum.

Throughout the initial part of World War I, most gun sights were simple ring-and-bead types that worked reasonably well but required accurate head positioning from the pilot. An optical (Aldis) sight was introduced during the latter part of the war and was much easier to use. A further advance was the reflector sight, which projected an aiming mark appearing at infinity on a sloped piece of glass through which the pilot sighted the target; a patent for a reflector sight was filed by Sir Howard Cribb as early as 1900, and in 1918 some Fokker Dr.Is of Jasta 12 were equipped with a German Oigee reflector sight for operational trials. The reflector sight came into wide use during the interwar years, although fixed optical sights continued to be used well into the 1940s.

Some air arms recognized the importance of deflection shooting and trained accordingly—the U.S. Navy being a prime example—but the training syllabus of many air forces did not emphasize air-to-air gunnery.

In 1936, Dr. L. Cunningham had suggested a "predictor" gun sight using the principle that a gyroscope resists any rotation of its axis. If one is attached to a normal gun sight, any attempt to follow a crossing target will be resisted with a force proportional to the crossing speed. This idea was adopted and developed by scientists at Royal Aircraft Establishment Farnborough, and the first preproduction Mark I Gyro Gun Sights (GGS) were installed on Spitfire and Defiant aircraft for trials in 1941. The tests were very promising, but there were a number of operational problems, and a redesigned Mark II GGS was rushed into production late in 1943. The pilot selected the type of enemy aircraft on a dial, then adjusted the sighting graticule to match the target's wingspan while tracking it. An analog computer in the sight calculated target range and offset the graticule to give the correct deflection.

The importance of the GGS is difficult to overestimate;

operational experience showed that it approximately doubled the effectiveness of the average squadron pilot. The GGS Mark II was formally accepted into the U.S. Army Air Forces as the K-14 and the U.S. Navy as the Mark 18.

A radar-ranging gun sight (the Davis-Draper sight) was tested by the U.S. Air Force between 1945 and 1948 and eventually went into production as the A-1B computing sight. The A1-CM was used on F-86 fighters during the Korean War and enabled hits to be scored at quite high deflection angles and ranges. However, it was quite fragile and suffered from inadequate maintenance.

In 1955, the U.S. Navy experimented with a head-up display (HUD). The flight-navigation and weapon-aiming symbology was generated electronically and projected onto a reflector glass in front of the pilot. The first production HUD was developed by Ferranti in 1962, and the Blackburn Buccaneer became the first operational aircraft to be fitted with it. HUDs initially used analogue computers to generate data, and the first digital HUD appeared in 1966.

The latest generation of helmet-mounted displays project HUD symbology onto the pilot's visor and track head movement, giving a look-and-shoot capability and allowing off-boresight engagements with short-range air-to-air missiles.

Andy Blackburn

See also

Aircraft Armament; Hartmann, Erich; Missiles, Air-to-Air

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Gunships

Side-firing airborne weapons platform. The gunship was a totally new weapons system at the time of its development. The concept originated in 1926 with a .30-caliber Lewis machine gun mounted on the wing of a de Havilland DH-4; it flew pylon turns to keep the gun on target.

The idea for the modern gunships came in 1964 from a U.S. Air Force officer, Captain Ronald W. Terry, who had heard of aircraft delivering mail and supplies to remote jungle areas in South America. The plane would circle in a steep pylon turn, lowering a bucket on a long rope. The bucket would orbit in a tight circle, suspended from the cargo door, and someone on the ground placed mail in it. Captain Terry suggested replacing the rope with a line of machine-gun fire.

Terry was assigned to see if the concept worked in practice, and he became one of the few individuals in military history who helped create a new weapons system and then tested it in combat himself.

The idea was tried with 10 .30-caliber machine guns mounted in an FC-47. Testing proved the concept, and the Air Force replaced the machine guns with three General Electric six-barrel rotating miniguns, reminiscent of Civil War–era Gatling guns. The 7.62mm guns were capable of covering every square foot of a football field with one round in one minute. The first of several successful day missions occurred on 15 December 1964; eight days later the first night missions were flown.

Although the gunship was effective, a better nighttime illumination system was needed. The standard flares, some dating to World War II, often did not work. The furious gunfire of the FC-47 raised South Vietnamese morale. The aircraft soon acquired affectionate nicknames such as "Puff" and "Dragonship." The call sign "Spooky" was assigned to early gunship operations in Vietnam.

The 7.62mm miniguns were excellent weapons but were in short supply. Terry got authorization to take 300 old M-2 .30-caliber machine guns and install them, 10 at a time, in four C-47s.

In 1965, Spooky's mission expanded to include interdiction of roads, trails, and rivers. The gunships—now designated AC-47s—had to operate low, slow, at night, and in bad weather. Forty-seven AC-47s went to Vietnam, and 12 were lost.

The United States had to try to interdict the flow of supplies from North Vietnam, and the obvious tool for the job was an improved gunship. Terry proposed a converted C-130A with improved sensors, weapons, and more ammunition. Four 7.62mm miniguns and four M-61 Vulcan 20mm cannons were installed in Gunship II, along with side- and forward-looking radar. A computerized fire-control system linking sensors and guns, and "inerted" fuel tanks protected against ground fire.

Although Secretary of the Air Force Harold Brown had authorized the C-119G as the AC-47's replacement, a costly compromise led to the creation of three types of gunships in the fleet: AC-47s, AC-119s, and AC-130s.

As the Air Force gained experience, the success of the gunships continued to rise. In 1969, AC-119Gs flew more than 3,700 sorties over 14,251 combat hours, fired almost 35 million rounds of ammunition, and expended 22,000 flares. They killed some 1,500 enemy troops and, most important, allowed no outpost to be overrun while they were overhead.

In the spring of 1972, North Vietnam began a major offensive. The gunships worked from Thai and South Vietnamese bases against targets in Cambodia, South Vietnam, and Laos. As North Vietnam stepped up its efforts, the work of the gunships expanded to provide more close support of the South Vietnamese army. There were many instances reported when the heavy fire from gunships halted overwhelming assaults on South Vietnamese positions.

Henry M. Holden

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Gurevich, Mikhail I. (1892–1976)

Military aircraft designer of the former Soviet Union. Born in a small village in the Kursk Oblast, Mikhail I. Gurevich finished high school and attended Kharkov University, studying physics and mathematics before being expelled for political reasons.

He temporarily emigrated to France in 1913 and took classes in mathematics at Montpellier University. After the Russian Revolution, Gurevich returned to Kharkov, where in 1925 he completed his studies at the Kharkov Technological Institute. He organized among fellow students a youthful faculty of aviation at the institute, which became an important center of aeronautical studies in the Soviet Union. After a period of sketching and building gliders, Gurevich in 1928 joined the Soviet aircraft industry and served as an assistant to various foreign and Russian engineers. Later, in the early 1930s, he participated in the Soviet think-tank for designing airframes, TsAGI (Central Aero-Hydrodynamics Institute). His facility with languages, diplomatic demeanor, and knowledge of airplane construction led to his appointment as a member of the Soviet team that in 1936–1937 negotiated with Douglas Aircraft the licensed transfer of DC-3s and DC-3 plans to the Soviet Union.

After assisting Boris P. Lisunov in setting up the DC-3 (Li 2) production line, Gurevich became a member of Nikolai N. Polikarpov's design bureau at the end of 1938. He applied his knowledge from the DC-3 experience to help Artem I. Mikoyan in devising a more effective production line for the Polikarpov fighter, the I-153. Late in 1939, Gurevich (deputy) and Mikoyan (chief) directed a new experimental department that had the approval and encouragement of the highest levels of party and government, including Soviet dictator Joseph Stalin. The experimental bureau focused on creating a high-performance fighter aircraft, the I 200. A prototype flew in March 1940, but extensive changes were necessary before the aircraft was ready for a small production run in December 1940. By then the model name had changed to the MiG-1, a designation based on the initials of the last names of the designers connected by an "i" (the Russian word for "and"). The most successful of the early models was the MiG-3, which enjoyed a production run of 3,300 and provided interceptor defense for the Soviet Union's metropolitan centers during World War II.

After the war, Gurevich and Mikoyan examined German technology and merged two BMW 003 turbojet engines with the MiG-9 airframe to create one of the Soviet Union's first successful jet fighters in April 1946. The MiG-9 entered full production and became the precursor for an array of famous fighter aircraft, ranging from the MiG-15 to the MiG-31. At the time of his retirement in 1964, Gurevich held the official post of chief constructor of the MiG OKB (Experimental Design Bureau). He received numerous Soviet awards and honors for his outstanding design achievements in military aviation, including the prestigious Lenin Prize in 1962.

James K. Libbey

See also

Douglas Aircraft; Mikoyan, Artem I.; Mikoyan-Guryevich Aircraft; Polikarpov, Nikolai N.; Soviet Air Force

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Guynemer, Georges (1894–1917)

The Hero of France during World War I. Frail in appearance and thought to be consumptive, Georges Guynemer nevertheless volunteered immediately upon the war's declaration and became an aviation mechanic. After pilot training in 1915, he was assigned to Escadrille 3, a unit that would become famous largely due to his performance. Over the next two years, his stork-emblazoned Nieuports and SPADs became the symbol of French aerial success as he ran his victory total to 53. He remained active in combat despite being injured several times.

Guynemer was one of a few pilots to fly the cannon-armed SPAD XII operationally, his four victories on the type making him its greatest exponent.

Guynemer was killed in action on 11 September 1917 under mysterious circumstances. He may be buried in Rumbeke, although this remains uncertain. The French air force is called out in his memory each year on the anniversary of his death.

James Streckfuss

See also

Nieuport Aircraft; SPAD Aircraft

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Haiphong Air Attacks

U.S. air campaign to close an important North Vietnamese port. North Vietnam relied on the Soviet Union, China, and other communist countries for war materials, all of which had to be imported, mostly by sea. By 1971, because of the Sino-Soviet rift and the warming relations between the United States and China, 85 percent of all military supplies entered North Vietnam through Haiphong Harbor.

Haiphong is located 10 miles north of the Gulf of Tonkin at the mouth of the Red River, the silt of which would close access were it not for dredges. As a kind of metaphor for the air war, these dredges were off-limits to U.S. bombing throughout the war. From 1964, the Joint Chiefs of Staff called for mining of the harbor, but the White House ruled that out for two reasons. First, President Lyndon Johnson feared that a mistakenly sunken Soviet merchant ship might lead to World War III. Second, Britain, France, and other U.S. allies traded with North Vietnam, and their ships regularly visited Haiphong Harbor.

Due to interservice rivalries between the U.S. Air Force and Navy, North Vietnam was divided into a system of route packages (known as "route packs") to evenly portion out the bombing. Haiphong was in Route Pack 6b and reserved primarily for naval air action, although Air Force sorties were sometimes targeted there. In June 1967, Air Force F-105s flying over the Cam Pha Peninsula north of Haiphong strafed the *Turkestan,* a Soviet freighter. The local USAF wing commander tried to cover up the incident and Washington denied that it had happened, but when Premier Alexei Kosygin presented President Johnson a 20mm slug with U.S. markings on it at the Glassboro, New Jersey, summit in July, denial turned to embarrassment.

Haiphong became fair game during Operation LINEBACKER. On 8 May 1972, as a part of a concerted air effort aimed at stemming North Vietnam's Easter Offensive, President Richard Nixon ordered Haiphong and the port at Dong Ha closed by mining. During his televised address on the evening of 8 May, Nixon announced that as he was speaking A-7 Corsairs and A-6 Intruders were sowing acoustical and magnetic mines across the harbor entrance. He gave shipping 72 hours to vacate the harbor, and then the mines would be activated. After 11 May, the harbor remained closed until the Navy started clearing the mines away on 5 February 1973, after the Paris Peace Accords brought an end to U.S. involvement in the war.

Like Hanoi, Haiphong suffered very little damage from U.S. bombing during either ROLLING THUNDER or the two LINEBACKER operations. For most of the war, the docking facilities and storage areas around the harbor were rarely targeted because of fear of collateral damage to Soviet or allied merchant vessels. But the closing of Haiphong Harbor during the critical days of the Easter Offensive of 1972 probably did more to turn the war in the favor of the United States than any other single operation. This one act effectively denied the North Vietnamese Army the supplies it needed to sustain a 14-division offensive inside South Vietnam. Given the increased pace of U.S. bombing along the infiltration corridors, and the stiff resistance offered by a better-trained and better-led Army of the Republic of South Vietnam, North Vietnam's big offensive was made to pay a price it could not afford.

Earl H. Tilford Jr.

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One of the finest close assault weapons of World War I was the Halberstädt CL.IV. Its success influenced German thinking on the coordination of air and ground attack in World War II. (Walter J. Boyne)

Halberstädt Aircraft

German aircraft manufacturer. The Halberstädter Flugzeugwerke firm designed and built a conventional line of single- and two-seat aircraft. Over the winter of 1916–1917, its D.II single-seat fighter was used alongside the Albatros D.II in the early *jagdstaffeln* (fighter squadrons), but the Albatros became the favored mount, and the Halberstädt soon disappeared from the front. Manfred von Richthofen used the type for a brief period following a lower-wing failure in his Albatros.

The company's primary claim to fame is associated with its line of light two-seaters, the CL.II and CL.IV. The CL class was originally conceived as a two-seat escort fighter that would protect the larger and heavier C-class two-seaters on bombing and artillery registration flights. With that assignment, the CL.II equipped the *schutzstaffeln* (protection flights) formed in 1917. When the units were redesignated *schlachtstaffeln* (battle flights) in 1918, their role was also switched to ground attack, and Halberstädt issued the slightly modified CL.IV. Both the CL.II and CL.IV were single-bay Mercedes-powered biplanes that carried a crew of two in a large, bathtublike cockpit designed for close communication. Pilot and observer each had a machine gun, and a small load of bombs was carried for use against ground targets.

James Streckfuss

See also
German Air Force (Luftwaffe)

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Halsey, William Frederick (1882–1959)

U.S. admiral and fleet commander during World War II. Born in Elizabeth, New Jersey, on 30 October 1882, Halsey attended the U.S. Naval Academy, graduating in 1904. His initial assignments were on surface ships, leading to command of two destroyers. Changing warfare specialties late in his career, Halsey became a naval aviator in 1935 and later commanded the carrier USS *Saratoga,* Pensacola Naval Air Station, and two separate carrier divisions. When Pearl Harbor was attacked, Halsey commanded all aircraft carriers in the Pacific Fleet.

President Harry Truman and Admiral William Frederick Halsey, Jr., confer on 19 October 1945. Halsey's smile may not have been sincere, because he had not received his promotion to Fleet Admiral, and would not until December of that year. (U.S. Navy)

In early 1942, his carrier forces struck deeply at the Japanese around the Marshall Islands and later escorted Colonel Jimmy Doolittle's B-25 bombers within striking distance of Japan, resulting in needed propaganda victories for the United States. Having Admiral Chester Nimitz's total confidence, Halsey commanded forces in the South Pacific and took over operations around Guadalcanal after efforts had stalled and success was in doubt. Halsey's aggressive approach turned the campaign around, and Guadalcanal was soon in U.S. hands. Illness forced Halsey to step down temporarily, turning command over to Admiral Raymond Spruance.

Halsey—dubbed "Bull" by the press—was later appointed to command Third Fleet. With carrier-based airpower, his forces won an overwhelming victory at Leyte Gulf in the Philippines, virtually eliminating the Imperial Japanese Navy as a fighting force. In the heat of combat, however, Halsey typically decided to seek out and destroy what was, in reality, a Japanese decoy force. His decision to split his forces deprived the vulnerable amphibious force of critical air cover, courting disaster. Halsey's carriers decisively engaged the Japanese at Cape Engano, destroying four carriers, but a Japanese surface force threatened the entire landing operation before being neutralized without Halsey's expected air support. Halsey's performance has been criticized ever since, and his professional reputation has suffered accordingly.

He was retained in command, and planes from Halsey's carriers struck the Japanese home islands in 1945. At war's end, Halsey was rewarded by promotion to five-star rank as fleet admiral. Due to poor health, Halsey retired from the Navy in 1947 and died at Fishers Island, New York, on 16 August 1959.

Halsey had been an early advocate of naval airpower, recognizing the preeminence of the carrier over the battleship in contemporary warfare. Throughout the war in the South Pacific, he effectively isolated Japanese strongpoints and outmaneuvered or outfought the Imperial Japanese Navy by relying on his own carrier-based airpower. His unswerving objective of hitting the enemy "hard, fast, and often" made him one of the most bellicose and colorful of America's wartime military leaders.

Michael S. Casey

See also

Cape Engano, Battle of; Doolittle, James H.; Gilbert Islands; Guadalcanal; Iwo Jima; Leyte Gulf, Battle of; Nimitz, Chester

William; Okinawa; Rabaul; Santa Cruz, Battle of; Spruance, Raymond A.

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Hamburg Bombing Campaign

Allied bombing of Hamburg (Operation GOMORRAH), one of the most destructive operations of World War II and ranking among the most devastating conventional bombing operations of all time. The vast scale of the bombing led to the first firestorm, an immense conflagration typically associated with nuclear weapons today. More than 50,000 people died in a week-long campaign against Hamburg in July 1943.

The RAF had carried out increasingly successful raids over many cities in the Ruhr and western Germany, reaching 1,000-plane strength against Cologne in May 1942. Area-bombing was thus far Britain's most potent weapon, and the chief of Bomber Command, Sir Arthur Harris, sought to bring the Nazis to their knees. He recognized that massive bomb tonnages must fall on German cities to achieve victory from the air. The success of these increasingly large strikes led planners to attempt concentrated attack campaigns against major cities. At the same time, technical advances made such large-scale attacks feasible. These included H2S, an early airborne radar system; Window (aluminum strips, or chaff, dropped from the air to confuse enemy radar); Pathfinder aircraft to mark targets; and the massing of sufficient four-engine bombers, primarily the Handley Page Halifax and Avro Lancaster bombers, to put enormous fleets in the air on a nightly basis. During this campaign, the United States continued to emphasize precision strikes but also contributed to the destruction of Hamburg, targeting shipyards, U-boat works, and electric generation plants.

Hamburg was a prime target. The second largest city in Germany and its leading port, Hamburg was home to shipyards, refineries, and other essential industries. Eliminating its many capabilities would greatly affect the German war effort.

On 24 July 1943, the RAF launched more than 700 bombers carrying a mix of high-explosive and incendiary bombs against the city. From their experience, British planners knew that a mix of bombs caused greater destruction and hindered damage-control efforts. After more than 100 raids, Hamburg had a well-trained, well-equipped civil defense program. However, the GOMORRAH bombing overwhelmed all possible countermeasures. General Harris intended to saturate Hamburg's fire and defensive services. If these could be inundated, then the effects of bombing could not be repaired; thus the offensive could move on instead of requiring repeated attacks.

Window rendered the strike force nearly invulnerable to radar interception, leaving German flak and fighters blind. Shortly after midnight, British bombers began dropping their bombs on Hamburg. Only 12 RAF bombers were shot down. Hamburg was pounded in one of the worst raids seen up to that point, leaving hundreds dead. The port was hit especially hard. U.S. daylight raids followed on 25 and 26 July.

The RAF returned on the night of 26–27 July. In two waves, the British again pounded the urban area with incendiary and high-explosive bombs. Water mains were ruptured, making firefighting nearly impossible. The thousands of unbridled fires created a never-before-seen phenomenon—the firestorm. As the air became heated, convection occurred, feeding the blaze with fresh air. Taking place in numerous places simultaneously, this generated hurricane-force winds, fanning the flames before it, spreading into unbombed areas, and consuming everything flammable. The city was destroyed. Those who found refuge in bomb shelters were often suffocated. The temperatures exceeded 1,500 degrees Fahrenheit, setting asphalt ablaze and melting glass, brick, and steel. The RAF would hit Hamburg twice more in the coming week, but the city was already a ruin. More than 50,000 people were dead, hundreds of thousands left homeless. More than half the city's buildings were rubble. Albert Speer reported to Hitler that war production would stop if the Allies carried out such raids on six more German cities.

The bombing of Hamburg heralded the enormous power of the aerial bomber and was a harbinger of the destructive conventional bombing raids such as those against Berlin and Dresden in February 1945 and the firebomb raids that wreaked devastation on more than 50 Japanese cities in 1945. Hamburg demonstrated that the most well-organized defenses could be overrun, the most regimented society broken by airpower. The incredible power of the air arm forecast by Douhet, Mitchell, and Alexander de Seversky in prewar writings had become reality. The airplane could bring about decisive results far from the battlefields by crippling the forces that sustained the armies in the field. Hiroshima, Nagasaki, and the advent of nuclear weapons would only make certain the potential for annihilation from the air.

James M. Pfaff

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Handley Page Aircraft (Early Years/World War I)

Frederick Handley Page was one of many aviation pioneers who founded a company on the hope that aircraft manufacturing would become a thriving business. Starting in 1908, Handley Page first concentrated on the production of monoplanes and, in 1912, offered flight instruction at Hendon. The firm's entry in the 1912 military trials, the Type F, ended in a crash that took it out of the competition. The company did not lose its competitive spirit, however, and in 1913 responded to the offer of £10,000 by the London *Daily Mail* to the first to fly across the Atlantic with the design of the L/200. The contest was interrupted by the outbreak of World War I before anyone could claim the prize. But the L/200 had given Handley Page experience in the design of large aircraft, and in December 1914, when the Admiralty issued a request for a large patrol bomber, the company began work on what would become the O/100.

The firm seems to have been the victim of more than a little bad luck with respect to its first big design. The O/100 first took to the air on 17 December 1915 but suffered from tail flutter in its initial tests. Engineering problems were worked out, and a year later the O/100 was ready for delivery to France. On 1 January 1917, O/100 No. 1463, crewed by Lieutenants H. C. Verker and S. R. Hibbard and three air mechanics, was on its way when the crew became lost in the fog and landed at Chalandry, on the aerodrome occupied by German Flieger Abteilung 208, providing the enemy with the bomber before the British. Later, on one of its first patrols over the English Channel, another O/100 crashed in the water and was lost. Following this, it was decided to switch the mammoth aircraft to night-bombing duties.

In mid-1917, the O/100 was replaced in government contracts by the O/400, which differed only in the design of its engine nacelle. The HP finally made it to operations in France in 1918 with the RAF Independent Force, but a decision was made early in the year to replace it with the Vickers Vimy. The Vimy had not yet appeared at the front, however, before the Armistice eliminated the need for large bombers. Meanwhile, Handley Page had produced the new V/1500, which served in the postwar Royal Air Force.

James Streckfuss

Handley Page Aircraft (Post–World War I)

The large Handley Page bombers of World War I were suitable for conversion to airliners, and Handley Page Transport began operations in August 1919. A long line of derivative aircraft followed, many of them being tested and adapted to the harsh climatic conditions of the Middle East and India. Most of these had the typical wood, metal, and fabric construction of the wartime aircraft, but some aircraft had all-metal structures.

Sir Frederick Handley Page was an aerodynamicist, the inventor (with R. O. Boswell) of the slotted wing. He patented both the fixed and the movable slot, which were used in many Handley Page aircraft and under license in others. (In Germany, Gustav V. Lachman also invented, in parallel, a similar slotted wing.)

The company manufactured a long line of advanced aircraft, including the Hendon torpedo plane and the very sleek Type S fighter, a low-wing cantilever monoplane. Many of Handley Page's advanced ideas came together in the oddly named Gugnunc, which placed second to the Curtiss Tanager in the 1929 Guggenheim Safe Aircraft Competition.

Handley Page continued in the bomber business with the Hyderabad biplane heavy bomber and the much more advanced—and very unusual-appearing—Heyford. The Heyford's biplane arrangement had the top wing faired into the fuselage, with the lower wing suspended well below on struts. The aircraft had a good performance for the time, and the 124 that were procured became the equipment of no less than 11 RAF squadrons.

The Handley Page biplane/slot formula was also used by Imperial Airways in the four-engine HP 42 airliner. Stately rather than swift, the HP 42 carried its passengers in comfort over the long routes that connected Great Britain to its empire. The 18 passengers were well served by a cabin crew that could produce seven-course dinners. Best of all, the eight aircraft in the series never had a fatal accident in a decade of service.

When World War II came, Handley Page contributed two important bomber designs—the Hampden and the Halifax. The twin-engine Hampden was a complete departure from past Handley Page practice, being streamlined, fast, and equipped with closely cowled engines, an enclosed cockpit, and retractable landing gear. Although its 254-mph top speed was fast for its time, it was not well armed and was vulnerable to German fighters. It served best at night, as a mine-laying aircraft, and in antisubmarine work. Some of the 1,432 Hampdens that were built were converted for use as torpedo-bombers.

After World War II had ended, Handley Page built 147 of its four-engine Hasting transports. This was followed by the very advanced four-engine Hermes, a sleek transport that was competitive with the contemporary Lockheed Constellation. One model was fitted with turboprop engines, becoming the largest and fastest four-engine transport flying at the time.

The Handley Page firm had great success with the Victor bomber and continued to experiment with very advanced projects, including supersonic airliners and flying jeeps. Despite some great designs, including the twin-turboprop Herald and the very modern Jetstream executive aircraft, the fire had gone out of the company with the death of Sir Frederick in 1962. He had seen the company grow from his first experimental gliders in 1909 to the 640-mph Victor of 1952. Only eight years after his death, the company was dissolved, unable to obtain the necessary financing to compete in the dwindling marketplace.

Walter J. Boyne

See also

Handley Page Halifax; Handley Page Victor

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Handley Page Halifax

British four-engine bomber; served at the heart of Royal Air Force night attacks on Germany as part of the Combined Bomber Offensive, as well as in several special mission roles. Large, almost rectangular, twin tailplanes and a smooth Perspex nose distinguished the later and more numerous versions.

Like its better-known cousin, the Avro Lancaster, the Halifax was a redesign of a twin-engine plan. Early versions used Merlin inline engines, though later models had Hercules radials. Various subcontractors produced or converted variants of the Halifax for coastal patrol, transport, glider-towing, and paratroop-drop missions.

Halifaxes made their first strike on occupied Le Havre, France, in March 1941. Operations continued through the war and after, with the last operational flight by an RAF Coastal Command Halifax in 1952.

The Halifax was a workhorse, noted for it smooth flying characteristics, at least in the later versions. Far more successful than its immediate predecessor, the Short Stirling, the Halifax was never modified to carry the extremely heavy blockbuster bombs that made the Lancaster more famous.

Grant Weller

See also

Avro Lancaster; Berlin Air Battles; Combined Bomber Offensive; Harris, Arthur T.; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Handley Page Victor

One of the triumvirate of British V-bombers that also included the Valiant and Vulcan. Designed to the same specification as the Vulcan, the Victor was unique in that it featured swept crescent wings and a T-shaped tail.

The prototype made its maiden flight in December 1952, with the first production aircraft flying three years later. Squadron service began in November 1957. Eventually, four units in RAF Bomber Command were equipped with the Victor B.1. Initially, the aircraft were finished in overall anti-flash white, although the switch to lower-altitude operations required that an upper surface finish of gray and green be applied.

Following on from the first version of the Victor came the more advanced B.2, which was later optimized to carry the Blue Steel standoff weapon. Primary changes to the airframe included an extended span that sported large underwing tanks. On the wing trailing edge were two aerodynamic fairings that were to eventually house electronic countermeasures equipment. Fitted from the outset was an inflight refueling probe. The Victor B.2 entered service in 1962 with No. 139 Squadron. With their arrival, earlier aircraft were withdrawn from service. However, the Victor B.1s were to gain a new lease on life when they were converted to tankers to replace the Valiants that had been grounded on short notice due to fatigue failure of the wing mainspar.

Not all the later Victors were completed as bombers; a handful emerged as SR.2s for the strategic reconnaissance role. This entailed the fitting of customizable pallets into the bomb bay to match mission requirements. During the mid-1970s, the aircraft of No. 543 Squadron were replaced by upgraded versions of the Vulcan designated B.2(MRR).

As with the Victor B.1, the surviving bombers and reconnaissance aircraft were converted into K.2 tankers. Their service spanned 20 years and involved operational flying in support of operations during the Falkland Islands War and the Gulf War.

Kev Darling

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Hannover Aircraft

Hannoverische Waggonfabrik had been a manufacturer of railroad rolling stock when, like other firms in related businesses, it was called upon by the government to make aircraft. Again like others, during the first half of World War I, the German firm built other manufacturer's designs under license until establishing a company drawing office and developing a type of its own. The Hannover CL.II was designed against the Luftstreitkräfte's request for a light two-seater for protection and, later, ground attack work. Light and strong, due to its plywood-covered fuselage, the Hannover ("Hawa," or "Hannoverana," as it was variously nicknamed) was powered by the ubiquitous Mercedes engine. It was a single-bay biplane, with a biplane empennage that made the tail quite compact, increasing the observer's field of rearward fire. Forward fire was provided to the pilot by a Spandau gun synchronized to fire through the propeller. The pilot's view was excellent, the deep fuselage almost filling the gap between the wings, putting the upper wing at eye level. The crewmen were seated in separate cockpits set close together. That similarity to the Bristol Fighter, along with the Hannover's small size, gave it a great advantage in combat. Enemy pilots would often lunge into the attack before realizing it was a two-seater they were up against, fire from the rear gun being their first warning.

Introduced at the end of 1917, the CL.II was refined during 1918 through the subsequent CL.III and CL.IIIa models. The difference between the III and IIIa was the engine, the latter having an Argus rather than the Mercedes, which, due to priority use, was being committed to single-seat fighters.

Along with Halberstädts, Hannovers equipped the *schlachtstaffeln* (battle flights) during the German spring offensive, performing dangerous ground attack missions then and throughout the remainder of the war.

James Streckfuss

See also

Bristol Beaufighter

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Hanoi Air Attacks

U.S. air campaign against what was considered to be the most heavily defended city in the history of aerial warfare. When they flew to Hanoi, U.S. pilots dubbed it "going downtown." Although Hanoi proper was never a target as major European and Japanese cities had been during World War II, U.S. Air Force and Navy aircraft struck bridges, petroleum storage facilities, and railyards in and around the city. At the height of Operation ROLLING THUNDER, one out of every 40 USAF fighter-bombers that "went downtown" did not return.

Hanoi, the capital of North Vietnam (now the capital of the Socialist Republic of Vietnam), sits astride the Red River about 75 miles inland from the Gulf of Tonkin. Although Hanoi was heavily defended, U.S. planes struck only intermittently, and the city itself was lightly damaged. From the start of ROLLING THUNDER on 2 March 1965 until June 1966, most of the bombing was in the panhandle. The White House assumed, and the State Department agreed, that bombing Hanoi posed two risks. First, it might prompt Chinese and Soviet intervention and escalation. Second, some thought if Hanoi lost its industrial base—consisting of three major factories—the effect would be like "killing the hostage." With no industrial base and nothing else to lose, Hanoi could not be threatened with losing what it no longer had. This Alice in Wonderland reasoning dominated civilian strategizing throughout ROLLING THUNDER.

Airpower advocates called for concerted bombing in and around Hanoi to destroy major targets like the Paul Doumer Bridge, the railways and highways leading the China, the petroleum, oil, and lubricant (POL) storage facilities, and railyards. Although an elaborate system of dikes and levies protected Hanoi from the seasonal flooding of the Red River, there was no consideration given to breaching those dikes as a way of destroying the city.

In June 1966, the first strikes hit Hanoi and Haiphong. For 30 days, Air Force and naval aircraft pounded POL storage facilities. Estimates are these strikes cost Hanoi 110,000 of its 185,000 tons of POL, leaving 75,000 tons stored at major airfields—which remained off-limits to bombing—and scattered about in small storage areas consisting of 55-gallon-drum caches placed in the center of small towns and villages. Because North Vietnam dedicated almost all POL to the war effort, losing even 60 percent of it had little effect on an army that moved more supplies on foot than in trucks.

Hundreds of antiaircraft guns, SA-2 surface-to-air missiles, and three major MiG bases formed a netted air defense system that made going downtown dangerous. Typically, Air Force crews, flying F-105 Thunderchiefs ("Thuds") with F-4 Phantoms as escorts, approached Hanoi from the northwest, below 1,500 feet along a spine of the Annamite Mountains consecrated as "Thud Ridge." Although low altitudes provided crews some protection against radar detection and surface-to-air missiles, they remained vulnerable to thousands of Vietnamese civilians firing rifles and to antiaircraft fire. Over Hanoi, they climbed above 10,000 feet, where SAMs and MiGs became the threat. Then the crews dove back into intense antiaircraft fire to release their bombs at around 6,000 feet and pull out below 3,000 feet. Even a single bullet from an AK-47 or a few fragments from an antiaircraft round could tear apart a jet engine, ripping off turbine blades that could sever fuel lines to start a fire or rip into hydraulic systems that negated use of controls. If the pilot survived the burning and exploding aircraft and high-speed ejection, he would be captured by angry villagers. If he made it to the Hanoi Hilton—the infamous POW installation—he faced years of barbaric torture. In 1966, 1967, and for most of 1968, an F-105 pilot assigned to Southeast Asia had about a 50-50 chance of surviving the tour. That is what "going downtown" meant.

In 1967, bombing focused on degrading the electrical power grid and bombing bridges. Neither was very successful. Backup gasoline generators provided sufficient power, and pontoon bridges, put in place at dark and removed before dawn, replaced the concrete spans over the Red River. In October 1968, ROLLING THUNDER came to an end, and Hanoi received a nearly four-year respite from bombing.

On 8 May 1972, President Richard Nixon, responding to North Vietnam's Easter Offensive, ordered targets struck throughout North Vietnam. The Paul Doumer Bridge, the Yen Vien railyards, and POL storage facilities were hit. For the first time, B-52s were used to bomb targets in and around Hanoi and Haiphong Harbor. Operation LINEBACKER lasted until the North Vietnamese leadership negotiated seriously, coming to an end when a peace agreement seem within reach on 23 October 1972. It was the most successful bombing campaign of the war in that it brought Hanoi to the brink of peace. But it took one more bombing campaign to clinch the deal.

When in December 1972 Hanoi recalled its negotiators from the Paris peace talks, Nixon unleashed airpower with a vengeance. During the 11 days of Operation LINEBACKER II, 739 B-52 sorties and 1,200 fighter-bomber sorties struck 334 targets in and around Hanoi, Haiphong, Vinh, and Thanh Hoa. The 20,000 tons of bombs dropped during the so-called Christmas bombing battered railyards and storage facilities. But most important, airpower rendered North Vietnamese air defenses useless by destroying its air-control headquarters and SAM assembly area. By December 29, North Vietnam was helpless against U.S. airpower. They agreed to negotiate, and the bombing stopped.

Antiwar activists claimed that the Air Force had carpet-bombed Hanoi, and North Vietnam's propaganda mill produced vivid photographic "evidence" to support those claims. But in reality damage to the city was light, as confirmed by aerial reconnaissance and visitors to the city.

Earl H. Tilford Jr.

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Hansell, Haywood S., Jr. (1903–1988)

USAF general. Born to Colonel Haywood S. Hansell in Fort Monroe, Virginia, in 1903, Heywood Shepherd Hansell Jr. graduated from the Georgia School of Technology in 1924 with a degree in mechanical engineering and was commissioned a second lieutenant in the Army Air Corps Reserve upon completing advanced flight training at Kelly Field, Texas, in 1929. He was assigned to the Second Bombardment Group at Langley Field, Virginia, in June 1930 and later served as armament officer of the Air Corps Tactical School. In August 1931, Lieutenant Hansell was transferred to Maxwell Field, Alabama, where he served with Captain Claire L. Chennault on the Army aerobatic team (Three Men on a Flying Trapeze).

Hansell graduated from the Air Corps Tactical School at Maxwell Field in June 1935. He stayed on as an instructor there, becoming affiliated with a group of young officers who espoused the belief that strategic long-range aircraft could destroy an enemy's industrial infrastructure. In 1939, upon completing the Command and General Staff School at Fort Leavenworth, Kansas, he was assigned to the office of the chief of the Air Corps, where he became assistant executive officer in September 1939. In November, Captain Hansell was transferred to the Intelligence Division and became chief of the Operations Planning Branch, Foreign Intelligence Section.

After a stint in London as a special observer in July and August 1941, he returned to the Air Staff War Plans Division in Washington, D.C. He transferred to the Operations Division of the War Department General Staff in April 1942 and served on the Joint Strategic Committee. Brigadier General Hansell commanded the 3d Bomb Wing and later the 1st Bomb of the Eighth Air Force in Europe and flew combat missions before becoming deputy commander in chief of the Allied Expeditionary Air Force. Hansell returned to Army Air Forces HQ as air planner on the Joint Planning Staff until he was given command of the new XXI Bomber Command on Saipan in August 1944, where he directed bombing raids on Tokyo.

Reassigned to the United States to head the 38th Flying Training Wing at Kirtland Field, New Mexico, in January 1945, he was later transferred to Air Transport Command HQ in Washington, D.C. At the war's end, he was commanding general of the Caribbean Wing, Atlantic Division, Air Transport Command, and retired from the USAAF on 31 December 1946. In July 1951, during the Korean War, Hansell was recalled to active duty and served as chief of the Mobilization Division, Directorate of Plans, in the office of the deputy Chief of Staff for operations at USAF HQ. Promoted to major general on 5 September 1952, Hansell was the senior Air Force member, Military Studies and Evaluations Division, Weapons Systems Evaluation Group, Office of the Secretary of Defense, in Washington, D.C. Awarded the Distinguished Service Medal, Legion of Merit, Silver Star, Distinguished Flying Cross, and Air Medal, General "Woody" Hansell retired from the USAF in May 1955 and died 14 November 1988.

Richard C. DeAngelis

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Hanson, Robert M. (1920–1944)

First lieutenant in the United States Marine Corp Reserve; World War II Pacific ace with 25 confirmed kills. Hanson flew with VMF-215 and was awarded the Congressional Medal of Honor, Navy Cross, and Distinguished Flying Cross.

Robert M. Hanson was born on 4 February 1920 in Lucknow, India. The child of missionary parents, he was a prewar heavyweight wrestling champion in the United Provinces. He witnessed the Nazi seizure of power in Austria firsthand.

Lieutenant Hanson joined VMF-215—the Fighting Corsairs—flying the F4U Corsair in August 1943 in time to participate in the landings on the Japanese stronghold of Bougainville. He also was involved with the 24 January 1944 New Britain Island operations. Hanson became an ace on 1 November 1943 after downing three Japanese aircraft for a total of five. VMF-215 claimed two other top Marine aces by the end of the war: Captain Donald N. Aldrich (20 kills) and Captain Harold L. Spears (15 kills).

Over Empress Augusta Bay on 1 November 1943, he engaged six Japanese torpedo-bombers, destroying one and forcing all to jettison their explosives before reaching their target. On 24 January 1944, flying high cover alone after being cut off from his division over enemy-held Simpson Harbor, Hanson attacked a large number of Zeros attempting to intercept U.S. bombers, shooting down four that were confirmed and claiming a fifth that was not. Hanson had developed a reputation as an aggressive and skilled aviator who often engaged the enemy in spite of their superior numbers.

On 3 February 1944, while strafing a lighthouse, which served as a flak tower and observation post, on Cape St. George, New Ireland, his aircraft was hit by flak. Hudson was unable to get out of the plane before it crashed into the ocean and disintegrated. He was 23 years old.

Robert Hanson shot down 25 Japanese aircraft between August 1943 and February 1944. He was the third, the youngest, and the last Marine Corsair pilot to earn the Medal of Honor.

Scott R. DiMarco

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Harris, Arthur T. (1892–1984)

Chief of RAF Bomber Command during much of World War II; nicknamed "Bomber" Harris, he became a figure of continuing controversy. He joined the Royal Flying Corps in 1915, becoming a fighter pilot, then served in a variety of interwar line and staff positions. By 1939, he commanded a Bomber Command group and rose to deputy Chief of Air Staff in 1940.

He was named chief of Bomber Command (and was knighted) in 1942. His was the initiative behind nighttime saturation—or, as his critics put it, indiscriminate—bombing. Harris argued that the RAF lacked the strength and technology for effective pinpoint bombing and could not sustain the aircraft and crew losses such attacks caused. He thus adopted urban area-bombing as a means of attacking German morale. He launched the first 1,000-bomber raid in May 1942, with more to follow.

From November 1943 into early 1944, his bombers concentrated on missions to Berlin in an attempt to knock Germany out of the war by strategic air attack alone. But mounting bomber losses, poor weather, and improving German air defenses limited the effort. With his dedication to the saturation campaign, Harris came into increasing conflict with Allied leaders who wanted a more flexible use of airpower, including tactical support of ground forces before and after D-Day.

The RAF bombing of Dresden in February 1945, which killed tens of thousands and destroyed much of that ancient city when the war was nearly won, quickly became infamous and remains controversial. Harris retired in 1946. He was overlooked in the customary end-of-war honors, although he was promoted to Air Marshal and in 1953 was created a baronet.

Christopher H. Sterling

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Hartmann, Erich (1922–1993)

The world's most successful fighter pilot. A member of the Luftwaffe's highest-scoring fighter wing, Jagdgeschwader 52 (52nd Fighter Wing), "Bubi" (Baby) Hartmann shot down 352 aircraft, 345 of them Soviet, while flying 825 combat missions. Hartmann was himself shot down 16 times and escaped once from brief Soviet captivity. He was the eighteenth member of the Wehrmacht to receive the Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross from Hitler.

On 8 May 1945, he surrendered to the U.S. Army, but as a member of an Eastern Front unit he was turned over to the Red Army, which held him until 1955. He was one of the last POWs to be released from Soviet captivity. He joined the Bundesluftwaffe—West Germany's postwar air force—and had a modestly successful peacetime career as a fighter pilot and unit commander until he spoke out against his unit's equipment, the Starfighter. He resigned as a colonel after 14 years of postwar service and became a civilian flight instructor. Hartmann never fully regained his health after his long imprisonment and died in 1993 at the age of 71.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Hawker Aircraft

The British firm H. G. Hawker Engineering, Ltd., was registered on 15 November 1920. T. O. M. Sopwith was the guiding spirit behind the new firm, which soon suffered an unexpected tragic loss when test pilot Harry Hawker was killed in a crash.

The company had Fred Sigrist as its works manager and Captain B. Thomson as its chief designer. Sydney Camm joined the firm in 1923, becoming chief designer in 1925 and beginning a series of designs that would prove to be mainstays of the Royal Air Force for the next half-century. Other key members who names would become famous were Fred Raynham and P. W. S. "George" Bulman.

Camm and Sigrist developed a system of metal construction that would prove to be key to a long series of first-rate designs. The most significant of the early developments was the Hart of 1929, which was faster than existing RAF fighters. A delightful aircraft to fly, the Hart was used throughout the British Empire. It inspired a two-place fighter variant, the Demon, whose later models featured a Frazer-Nash turret. More than 17 variants of the basic Hart were built—a total of some 3,020 aircraft, a tremendous production run for a fabric-covered biplane. The variants included the Audax, Demon, Hardy, Hector, Hind, Hoopoe, Nimrod, Osprey, and several others.

The principal fighter variant of the series was the lovely Fury, the first aircraft supplied to the RAF that was capable of more than 200 mph. The aircraft was widely exported, flying for Yugoslavia, Persia, Portugal, Norway, and Spain.

Sydney Camm knew that the biplane formula, however refined, was now obsolete and in 1933 (after the firm had grown to become Hawker Aircraft Ltd.) forwarded proposals for a monoplane fighter replacement. By 1934, the design had been refined to include a Rolls-Royce Merlin engine, retractable landing gear, an enclosed canopy, and a radical

One of the most advanced Hawker-Siddeley designs was developed into the Hawker Harrier, capable of a vertical takeoff. (Walter J. Boyne)

The Hawker Sea Fury served in Korea in the ground attack role. Some surviving examples race at Reno. (Walter J. Boyne)

Often overlooked because of the interest in the Supermarine Spitfire, the Hawker Hurricane was nonetheless the most important RAF fighter in the Battle of Britain. (U.S. Air Force)

new armament package featuring four guns in each wing. This plane was the Hurricane, and it was first flown on 8 November 1935 by Bulman. This was also the year in which the firm expanded, acquiring Gloster to form the Hawker-Siddeley Group. By June 1936, sufficient tests had been passed to earn an order for 600 aircraft, a massive number for the time.

The Hurricane was followed by the Typhoon and Tempest aircraft, much more sophisticated but still plainly showing their Sydney Camm origins.

After the war, Hawker entered the jet age with enthusiasm, producing a long series of designs including the Sea Hawk and the Hunter. The most advanced Hawker-Siddeley design was the Kestrel, a vertical-takeoff fighter that would be developed as the Harrier. The Harrier would be manufactured both by Hawker-Siddeley and McDonnell Douglas. In 1977, under legislation by the British government, a corporation called British Aerospace was created, made up of British Aircraft Corporation, Hawker-Siddeley Aviation, Hawker-Siddeley Dynamics, and Scottish Aviation.

Walter J. Boyne

See also

Camm, Sydney; Gloster Aircraft; Hawker Hunter; Hawker Hurricane; Hawker Typhoon and Tempest; Hawker-Siddeley Aircraft; Sopwith, Thomas O.M.

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Hawker Hunter

The British Hawker Hunter first flew in July 1951 and entered service with the RAF in July 1954. The Hunter was regarded as a pilot's airplane—stable, responsive, pleasant to fly—and would exceed the speed of sound with barely a twitch on the Mach meter. It was a highly aerobatic, rugged, and elegant aircraft; its only real fault was a shortage of range, particularly in the earlier versions.

Hunters were involved in several air combats during the Indo-Pakistani wars and in the Middle East. The Hunter was similar to the MiG-19 at medium to low levels in speed and turn rate, although the MiG could roll faster. Compared with the late-model F-86 Sabre, the Hunter had better acceleration, deceleration, and climb but was generally inferior in a turning fight except at high Mach.

Almost 2,000 fighter (F.1–F.6) and trainer (T.7–T.8) versions of the Hunter were produced in the United Kingdom and under license in Holland and Belgium, and many T.7, T.8, FGA.9, FR.10 and GA.11 aircraft were converted from earlier marks. The Hunter was operated by 19 countries, and some examples were still in service with India and Zimbabwe at the turn of the twenty-first century.

Andy Blackburn

See also
India-Pakistan Airpower

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Hawker Hurricane

The mainstay of RAF Fighter Command during the early years of World War II. The Hurricane saw front-line service in fighter, tactical reconnaissance, and ground attack roles until after the end of hostilities. During World War II, Hurricanes served in every theater and shot down more enemy aircraft than any other Allied type and more than all other British aircraft types combined. Approximately 14,670 Hurricanes and Sea Hurricanes were built between November 1935 and September 1944.

The Hurricane I was a docile but highly maneuverable airplane, a very stable gun platform. It was also extremely strong, being capable of withstanding maneuvers that would pull the wings off many contemporaries. The Hurricane I was 30–40 mph slower than the Spitfire I but had a better turning circle and a superior rate of roll, particularly at high speed, although it tended to lose out above 20,000 feet because of its thicker wing.

The Hurricane II entered RAF service in September 1940 and had an uprated Merlin XX of 1,260 bph; the Mk.IIB was armed with 12 0.303-inch Browning machine guns; later Mk.IICs had four 20mm Hispano cannons. The Hurricane Mk.IID was a specialized antitank version with two 40mm cannons and was mainly used in the Western Desert and Russia; the Mk.IV had additional protective armor and a universal wing that could accept 40mm cannons, rockets, or bombs.

The Sea Hurricane Mk.IB and Mk.IIC were broadly equivalent to the standard Hurricane Mk.I and Mk.II but had slightly lower performance due to the extra equipment fitted (such as catapult spools, arrester hooks). During 1942 and well into 1943, Sea Hurricanes were the Royal Navy's primary air defense asset.

Andy Blackburn

See also
Aircraft Armament; Britain, Battle of; Camm, Sydney; Pattle, Marmaduke Thomas St. John; Supermarine Spitfire

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Hawker-Siddeley Aircraft

The Hawker-Siddeley Group once comprised Hawker, de Havilland, Gloster, Armstrong Whitworth, Armstrong Siddeley, A.V. Roe, Folland, and Blackburn. This situation remained unchanged until a major reorganization undertaken in 1963 that saw the emergence of Hawker-Siddeley Aircraft (HSA) and Hawker-Siddeley Dynamics (HSD). Eventually, Hawker-Siddeley would be subsumed into a government-organized conglomerate.

The new HSA company carried on manufacturing the products of the original companies, changing only the type prefix to HS. Thus, the Argosy freighter was redesignated from the AW650 to the HS650, the Avro 748 to the HS748. Other aircraft under the company's umbrella were the Hunter and the Buccaneer, as well as the Dominie T.1 navigation trainer. Another trainer and light strike aircraft built under the aegis of HSA was the Gnat T.1, which was also built under license in India as the Ajeet.

Products developed and built by HSA alone included the Hawk trainer, which replaced the Gnat in RAF service. This was followed by the most prestigious of programs: the Harrier jump jet. Developed from the P1127 experimental aircraft via the Kestrel multinational development aircraft, the Harrier continues in development and production to this day.

HSA was also responsible for development of the HS801 Nimrod antisubmarine aircraft. The initial testbeds for the Nimrod were conversions of a pair of unsold Comets. The Nimrod has undergone continued development since introduction, and 22 examples are now being rebuilt to the MRA.4 standard for continued service.

HSD became responsible for developing weaponry for the companies' products. Missiles developed by and supported by HSD included the Firestreak and Red Top missiles for the Lightning. Missiles sponsored by HSD included the U.K. versions of the Martel TV guided missile.

Both companies disappeared in 1977 after the enforced merger with Britain's other U.K. aviation companies to form British Aerospace. The Dynamics division name survived a little longer until the whole conglomerate was renamed BAe Systems in 1999.

Kev Darling

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Hawker Typhoon and Tempest

British World War II fighter-interceptors. The Typhoon entered operational service with the RAF in September 1941. A large and powerful fighter, it was designed as an interceptor, but its high-altitude performance was disappointing because of its thick wing; it had very effective armament and was a good gun platform. It was also the first operational fighter to be fitted with a bubble canopy that gave unrestricted rearward vision.

The Typhoon's introduction into service was rushed, and it gained a reputation for unreliability; the Napier Sabre engine was initially unreliable, there were problems with carbon monoxide seepage, and the aircraft was prone to flutter-induced failure of the entire tail section. All these problems were eventually resolved, and the Typhoon became an effective ground attack fighter, distinguishing itself during the Battle of the Falaise Pocket in 1944. In combat, the Typhoon was not a particularly agile aircraft but could turn slightly tighter than the Focke-Wulf Fw 190A; it was not as good in a climb but slightly better in a dive; its rate of roll was much lower, but it was slightly faster at all heights. More than 3,300 Typhoons were built, all of them serving with the RAF.

The Tempest prototype was converted from a production Typhoon and was initially designated Typhoon II. It had a new, thinner, laminar-flow wing and revised tail surfaces. The major production version (Mark V) was about 20 mph faster than the Typhoon. It was an even better gun platform and had the same bubble canopy; it entered service in February 1944.

In combat, the Tempest was more responsive than the Typhoon and had spring tab ailerons that gave it a particularly good roll rate at high speed (up to 545 mph). A heavy and very clean aircraft, its dive acceleration was outstanding. The Tempest was about 40 mph faster and had much better dive acceleration and zoom-climb capabilities than the Fw 190A. Turning circles were very similar, but the Fw had a much better rate of roll. The Tempest was 40–50 mph faster than the Bf 109G-2, but its climb was not as good. It had slightly better zoom-climb and dive acceleration, it could turn tighter, and it had a better rate of roll above 350 mph.

The Tempest V was very successful in combat; it had sufficient performance to shoot down German jets and was heavily involved in the defense of southern England against V-1 missiles. It was probably the best low- to medium-altitude fighter of World War II. Almst 1,400 Tempests of various marks were built, and some remained in RAF service until June 1951. Both aircraft types were fitted with various versions of the Napier Sabre engine.

Andy Blackburn

See also
Aircraft Armament; Camm, Sydney; Falaise-Argentan pocket; Focke-Wulf Fw 190; Messerschmitt Bf 109; V-1 Missile and V-2 Rocket

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Heinemann, Edward H. (1908–1991)

Aeronautical engineer. Edward H. Heinemann received the Collier Trophy in 1953 for his design of the Douglas F4D "Skyray," the first carrier-based fighter aircraft to reach Mach 1 in level flight. Heinemann's auspicious career resulted in more than 20 fighter, bomber, and rocket aircraft.

After having worked on the Northrop Gamma, Heinemann is known for the Douglas SBD and DB-7, the AD series, D-558 research aircraft, F4D Skyray, A-3 attack bomber, and the sleek A-4D1 Skyhawk. His are remarkable achievements, for he left school at age 17 to work as a draftsman, studying mathematics and engineering on his own.

Hired in 1926 to work for the Douglas Aircraft Company, Heinemann accepted a position at the Northrop Corporation in 1932 and was elevated to chief engineer when it became the El Segundo Division of Douglas Corporation. He designed the Northrop XBT-1, the first all-metal low-wing monoplane built to U.S. Navy specifications. The XBT-1 led to the SBD Dauntless, which joined the U.S. Navy fleet in 1938.

To develop a bomber that would compete favorably in weight, load-carrying capability, and performance, Heinemann designed the versatile AD-1 Skyraider, modifying it at the last moment to utilize the R-3350 power plant. In 1944, he collaborated to design a research aircraft that would take off under its own power and approach the speed of sound. Heinemann designed the D-558-1 Skystreak and the D-558-2 Skyrocket. In 1947, Heinemann started the design that would become, in 1951, the F4D for which he received the Collier Trophy.

Ed Heinemann received the Guggenheim Medal in 1978 and the National Medal of Science in 1983. He was enshrined in the National Aviation Hall of Fame in 1981 and the International Aerospace Hall of Fame in 1982. A unique leader and outstanding engineer, Ed Heinemann retired in

1973 from his position as General Dynamics's corporate vice president of engineering and became an aeronautical consultant. Born in Saginaw, Michigan, on 14 November 1908, Heinemann died on 26 November 1991 at the age of 83.

Charles Cooper and Ann Cooper

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Heinkel Aircraft

German aircraft manufacturer. Ernst Heinkel (1888–1958) built his first airplane in 1911 but was seriously injured when it eventually crashed. He worked subsequently for Albatros, Hansa-Brandenburg, and Castiglioni, designing seaplanes for the latter. Heinkel formed his own company in 1922 and produced a variety of fighters, trainers, and observation aircraft for export.

Of all the German companies, Heinkel was most devoted to military aircraft by the early 1930s. The company was reorganized in 1935 and moved to larger quarters. The He 51 biplane fighter entered service in 1936 and fought in the Spanish civil war. The He 59 was designed as a torpedo-bomber and for use in reconnaissance. The He 70 fast mailplane was turned to military service. The He 72 Kadett trainer was widely used. The twin-engine He 111 was also initially designed for airline use but became the most widely used (more than 7,000 copies) German bomber. The He 112 lost out to the Bf 109 as the standard German single-engine fighter aircraft.

One of the most notable achievements was the world's first flight of a jet aircraft, the Heinkel He 178, flown by Erich Warstiz on 27 August 1939.

The He 115 was a twin-engine floatplane used for reconnaissance and minelaying as well as torpedo-bombing and first flew in 1938. After production of nearly 140 examples, the aircraft was phased out as obsolescent by late 1940.

The He 162 Salamander became an operational jet fighter—more than 800 were being manufactured at the very end of the war. The sophisticated He 177 Greif (Griffon) first flew in 1939 but never overcame engine overheating problems (with its four engines coupled in two nacelles) to become the successful heavy bomber intended. The He 219 Uhu (Owl) made a successful night-fighter in limited numbers (nearly 300) after 1943. By late 1944, the 27 subsidiary plants and factories employed nearly 50,000 workers. Heinkel was reformed in 1955 and participated in several multination airplane projects. In 1964, it was merged into VFW and disappeared as a separate firm.

Christopher H. Sterling

See also

Heinkel He 111

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Heinkel He 111 (1934–1945)

German commercial transport and military bomber. The high-speed, low-wing, twin-engine monoplane was state-of-the-art when designed in 1934 but remained in service until 1945, when it was long obsolete.

He 111As were underpowered, and improved engines enabled the Kondor Legion's He 111Bs and He 111Es to achieve great success in Spain. Six He 111Cs served with Lufthansa but proved cramped and uneconomical. Bottlenecks in Daimler Benz engine production prevented large numbers of He 111Ds and He 111Ps from entering service. Turkey purchased 40 He 111Fs with improved wing design. Initially designed as torpedo-bombers, 90 He 111Js served as conventional bombers. Twelve "Siamese twin" He 111Zs were built as monstrous glider tugs. He 111Hs were the most widely used version, known for pleasant handling, good stability, and maneuverability. He 111s had five seats, one cannon, four to five machine guns, and up to 5,512 pounds of bombs. With maximum bombload, maximum speed was 217 mph, range was 1,212 miles, and ceiling was 21,980 feet.

Some 7,300 He 111s were built and served on every front. Defensive armament proved inadequate even in Poland and Norway, and He 111s suffered such heavy attrition against Britain that they flew only night sorties after mid-September 1940. Moreover, range and bombload were insufficient for truly effective strategic bombing. Torpedo-armed He 111s inflicted heavy damage on Allied convoys in the Arctic and Mediterranean in 1941–1942. They performed well enough as tactical bombers against the Soviets but lacked the range to reach industrial targets in the Urals. After 1943, He 111s mainly served as transports, although some launched mines, guided weapons, and V-1 rocket-missiles (including 1,200 V-1s against Britain).

James D. Perry

With uses such as command and control, liaison, reconnaissance, wire laying, rotation of troops in the battle line, plane guards (ready rescue) on aircraft carriers, supply of frontline troops, adjustment of artillery fire, and artillery raids, helicopters have become indispensable to military forces. (Walter J. Boyne)

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Helicopter Operations in the U.S. Army

Since it first procured small Bell YR-13 helicopters in 1946, the U.S. Army has found increasing uses for helicopters, including incorporation into the combat arms.

The Korean War provided the Army its first opportunity to use helicopters in combat. In early 1951, the Army's H-13 Sioux assumed the medical-evacuation role from the Air Force, thus enhancing the survivability of wounded soldiers. H-13s and H-23 Ravens were also distributed to combat commands for experimentation. Without doctrine to guide them, Army commanders were soon using them for liaison, command and control, supply, wirelaying, river-crossing, artillery fire adjustment, and reconnaissance. Encouraged by Marine successes with transport helicopters, the Army sent two H-19 Chickasaw companies to Korea to experiment with troop movement and supply of front-line troops. The experiments were successful, convincing the Army that it had made the correct decision to organize 12 transport helicopter battalions.

The Vietnam War has been called the "Helicopter War" with good reason. After U.S. support began in 1961, few operations were begun without helicopter lift of troops. To counter guerrilla ambush tactics against South Vietnamese troops, the Army injected H-21 Shawnee helicopter transport units into Vietnam in 1961. Flying South Vietnamese troops into combat, U.S. officers developed immediate response units called "Eagle Flights" that used various tactics to destroy guerrillas.

Because landing zones came under enemy fire, the Army put machine guns in H-21 doorways for suppressive fire when landing, but this was unsatisfactory. In 1962, the Army sent armed UH-1 Hueys to Vietnam to escort the troop transports. As UH-1s replaced the H-21s for troop-carrying, the armed Hueys proved too slow. Using UH-1 components, Bell Helicopter developed the AH-1 Cobra attack helicopter especially for the escort and attack roles. Some critics thought that all helicopters would be shot down, but the machines proved tough and survivable.

President Lyndon Johnson's decision to send U.S. troops to fight the war in 1965 brought a new phase to helicopter warfare. Trained in airmobile operations, the 1st Air Cavalry Division (Airmobile) demonstrated its ability to fight North Vietnamese regulars in the Ia Drang highlands. Using CH-47s, the division airlifted artillery to firebases prior to airlifting troops to give them adequate fire support. Combined with close air support and armed Hueys, the 1st Air Cavalry Division had great combat power.

As the number of units in Vietnam increased, they had helicopter units attached to them in addition to their own organic aircraft. The 1st Aviation Brigade was organized to control, maintain, and train these attached helicopter units. The brigade adopted a policy of decentralized control of its units, sending them where they were most needed.

The survivability of helicopters in combat was questioned from the beginning of the war, but never as intensely as during Operation LAM SON 719. In February and March 1971, U.S. helicopters flew South Vietnamese troops into Laos to destroy huge enemy supply dumps and to disrupt enemy movements south. The North Vietnamese countered with tanks and a sophisticated air defense. They shot down 107 helicopters, but Army leaders believed that the destruction of supplies justified the helicopter loss, set at one-fourth of 1 percent of sorties flown.

LAM SON 719 and the Easter Offensive of 1972 enabled the Army to use helicopters as antitank weapons. Using mainly antipersonnel munitions in LAM SON 719, AH-1 Cobras destroyed six tanks and immobilized eight. After North Vietnamese armor poured across the demilitarized zone in the Easter Offensive of 1972, helicopters helped stop them. UH-1s armed with TOW missiles destroyed more than 50 tanks and other vehicles, the first major use of helicopters in the antitank role. During this offensive North Vietnamese troops fired SA-7 heat-seeking missiles at helicopters. This necessitated modifying helicopter exhausts to direct them upward into the rotor wash, thus reducing the heat signature. Helicopters were also fitted with decoy flares.

In the 1980s, Army helicopters were used in two major operations. In the invasion of Grenada in 1983, UH-60 Black Hawks carried Delta Force troops to attack Richmond Hill Prison. Of the 14 Black Hawks participating, seven were heavily damaged and one shot down, so the mission was aborted. Four Black Hawks carrying Rangers from Barbados attacked Calvigny compound, resulting in the destruction of three of them when they met heavy fire upon landing.

In the 1989 Panama invasion, the Army made extensive use of helicopters already positioned at its Panamanian installations. When 82d Airborne Division units parachuted at Panama's airport, UH-60s picked them up for air assaults on key Panama Defense Force strongpoints. An AH-1 Cobra supported an air assault by two UH-60s inside a prison holding political prisoners.

The 1991 Gulf War witnessed a most intense and successful use of helicopters. Coalition strategy required a joint force to hold the southern boundary of Kuwait while an amphibious force threatened a landing on the Kuwaiti coast. Thus fixed in place to meet both threats, Iraqi forces would be unable to stop another secretly assembled joint force from swinging shut like a giant door against the Euphrates River. This movement would trap Iraqi forces inside Kuwait and permit the destruction of their equipment.

The giant door, hinged at the southern Iraq–Kuwait border, consisted of the most mobile joint forces, especially the VII Corps, heavy in armor, and the XVIII Airborne Corps, heavy in air assault troops. Both corps had fighting helicopter units that had trained with their divisions.

The main helicopters used included OH-58 Kiowas for scouting and targeting; AH-64 Apaches for antitank and reconnaissance missions; AH-1 Cobras for escort and antitank use; UH-60 Black Hawks for troop transport, command and control, and electronic countermeasures; and CH-47 Chinooks for troop transport, supply, and artillery placement. With their ability to fire 30mm cannons, 70mm rockets, and Hellfire laser-guided missiles, and to see through rain and dark, the Apaches had the greatest combat power.

Before the ground war started, helicopter units had several important duties. First was to screen the assembling VII Corps and XVIII Corps so that the enemy could not detect them. Next was to conduct reconnaissance across the desert to find suitable places for forward refueling and rearming points. An important mission for Apaches was to destroy two Iraqi border radar sites to give the USAF clear airspace toward Baghdad. Flying low after dark to avoid detection, the Apaches attacked at a standoff distance of two kilometers with missiles.

When the ground war began, Apaches and Cobras flew in advance of VII Corps to provide intelligence on enemy positions and to attack armor. Kiowas and Cobras flew flank security to warn against approaching Iraqi forces and to contact friendly units. To avoid VII Corps artillery fire, it became necessary to send helicopters some 12 miles in advance of the battle line. Apaches had a field day killing armor and other vehicles.

The most mobile unit in the XVIII Airborne Corps was the 101st Airborne Division (Air Assault). It formed the edge of the swinging door and had to advance some 200 miles by the second day of battle. This rapid advance was made possible by Chinooks and Black Hawks, which carried troops and supplies, especially ammunition and fuel. Without the advanced ammunition and fuel, Apaches could not have closed the door at the Euphrates. Near the river, Apaches of the 101st Airborne killed hundreds of vehicles that were backed up while trying to flee Kuwait. They also blocked the causeway across the marshes with wrecked vehicles and destroyed a pontoon bridge across the river. Although a cease-fire was in effect on February 28, the Iraqi Hammurabi Division offered combat on March 1, and the Apaches and Cobras destroyed its equipment. Overall, helicopters proved indispensable for waging midintensity warfare against this well-armed foe.

John L. Bell

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Helicopters

From their first practical development in the 1930s, helicopters have gradually become indispensable to military forces.

Development and Early Military Use

Anton Flettner of Germany was the first person to develop a helicopter used in military operations. His Fl 282 in 1942 served the liaison role on German warships in the Mediterranean and Baltic Seas. In 1944, Flettner's Fl 285, carrying two depth charges, was the first antisubmarine warfare (ASW) helicopter.

Encouraged by Igor Sikorsky's development of the VS-300 helicopter in 1940, the U.S. military services ordered about 400 Sikorsky helicopters during World War II (models R-4, R-5, and R-6). In 1944, a light rescue airplane was forced down behind Japanese lines in Burma. A U.S. Army R-4 rescued the pilot and three casualties. Thus began the medical-evacuation role. In early 1945, the Army Air Forces used R-5s for search and rescue in Burma and China. In January 1945, two Sikorsky HNS-1s were placed on a British merchant ship for convoy air patrol across the North Atlantic. The rough weather made it impossible for them to fly until 10 days out, so they were considered unsuitable for the ASW mission.

Beginning in early 1945, the U.S. Navy began experimenting with sonar-dipping helicopters for ASW use. These experiments led to the commissioning of the first ASW squadron at Key West in 1951. It used the Piasecki HUP. In 1961, the SH-3A Sea King became the first U. S. helicopter designed for ASW use.

The U.S. Marines experimented with helicopters for amphibious landings after World War II. The Bikini tests showed how a nuclear blast could devastate a fleet assembled for a traditional amphibious landing. The Marines believed that in the future ships must be dispersed lest they become nuclear targets. This would make amphibious landings very difficult. To solve this problem, the Marines formed an experimental helicopter squadron in 1947 to develop tactics and doctrine for helicopter assaults from the sea. Although the helicopters of the time were inadequate, the Marines devised the needed doctrine while waiting for better machines. Conventional landing craft would still be needed after helicopter assaults had secured a beachhead.

Development of Tactics and Doctrine

The U.S. Navy tested helicopters after World War II for mine countermeasures (MCM). The first use of helicopters for MCM occurred in the Korean War when helicopters were used to locate mines in Wonsan Harbor. The Navy commissioned its first MCM squadron, HM-12, in 1971. Receiving CH-53A Sea Stallions at first, the squadron later procured RH-53Ds, designed specifically for MCM. This squadron cleared mines from Haiphong Harbor in 1973 and from the Suez Canal in 1974 and 1975.

In addition to MCM development, the Korean War saw the first combat uses of helicopters in many roles: command and control, liaison, reconnaissance, wirelaying, rotation of troops in the battle line, plane guards (ready rescue) on aircraft carriers, supply of front-line troops, adjustment of artillery fire, and artillery raids.

As communist guerrillas threatened British control of Malaya from 1948 to 1960, the British used helicopters in counterinsurgency operations. The French also fought insurgencies in Vietnam and Algeria in the 1940s and 1950s, but in neither case did helicopters assure victory. Helicopters did provide mobility and firepower in Algeria, where Muslim guerrillas struck at will in the countryside. While landing troops near rebel bands, the French discovered that they needed suppressive fire. This could best be provided by an armed helicopter capable of flying with the troop transports. Various configurations of weapons were hung on helicopters, and a combination of machine guns and rockets worked best. Consequently, the French were the first to develop the technique of an air assault amid an armed enemy.

The French experience caught the attention of the U.S. Army, which was developing tactics and doctrine for waging war on a nuclear battlefield. Generals James Gavin and Hamilton Howze were the leaders in this movement. In 1962, Secretary of Defense Robert McNamara ordered the Army to convene a Tactical Mobility Requirements Board at Fort Bragg to test ideas of air mobility and air assault. Headed by General Howze, this board conducted many tests and concluded that these ideas were feasible. The Army next organized the 11th Air Assault Division (Test) at Fort Benning in 1963 to conduct exercises and develop tactics and doctrine. An aviation brigade was organized to support the division. The 11th Air Assault Division was converted into the 1st Air Cavalry Division (Airmobile) and sent to Vietnam, where it proved the validity of the concepts. A similar division, the 101st Airborne Division (Air Assault), was later organized and proved its worth in the Gulf War.

The Vietnam War provided several innovations in helicopter warfare. Units specially trained in airmobile and air assault tactics were used for the first time. The introduction of the AH-1 Cobra marked the first time that the attack helicopter was used in warfare. Cobras and TOW-armed Hueys were used as antitank weapons. Heavy-lift helicopters gave greater mobility by moving heavy equipment. The CH-54 Tarhe (Sky Crane) and the CH-53 Sea Stallion provided this heavy-lift capability. The U.S. Army also received the first specially designed scout helicopter—the OH-6 Osage.

The Afghanistan War (1979–1989) marked the first extensive use of Soviet helicopters in counterinsurgency warfare. Soviet operations against the mujahideen used mainly the Mi-8 Hip and the Mi-24 Hind. The Mi-8 carried troops, and the Mi-24 was an attack helicopter. Hampered by a lack of air assault doctrine and experience in mountain fighting, the Soviets at first appeared inept. The mujahideen repelled air assaults at first with machine guns, rocket-propelled grenades, and mortars. As the Soviets became more proficient in air assaults, the mujahideen countered with captured SA-7 heat-seeking missiles and U.S. shoulder-fired Stinger missiles. These missiles, employed about 1988, proved devastating to helicopters. Having lost some 800 helicopters and thousands of troops, the Soviets withdrew from the war.

The Falkland Islands War (1982) demonstrated the great utility of helicopters in long-range naval warfare and amphibious operations. Both the British and the Argentines used helicopters, a total of about 200. Naval helicopters provided ASW protection for the British fleet around the clock. When an Exocet missile damaged a British destroyer, helicopters rescued the crew. Although most amphibious landings were made by landing craft, helicopters were essential in supplying the troops and providing suppressive fire as they moved to capture the town of Stanley.

The U.S. Navy commissioned the first Light Airborne Multipurpose System (LAMPS) squadron in 1973. The LAMPS system gave helicopters with various sensors to smaller ships to extend their eyes and ears and to integrate helicopter sensors with the ships' weapons and targeting systems. In 1984, the Navy established the LAMPS Mark III program, using SH-60B helicopters. These aircraft could detect submarines with acoustical devices or by magnetic anomalies. Distant ships, aircraft, or missiles showed up on the helicopters' radar. Sensor data could be transmitted directly to the ship for defensive response. The SH-60Bs, equivalent to the Black Hawks, could carry an array of weapons, including homing torpedoes, depth charges, and air-to-ship missiles.

While the Navy was improving its defensive capabilities, the U.S. Army was developing a new attack helicopter. The result was the AH-64 Apache. This helicopter has the ability to fly and acquire targets in all kinds of weather and attack with an array of weapons. During the Gulf War, Apaches formed the spearpoints of the two maneuver corps. They functioned as aerial main battle tanks, firing laser-guided Hellfire missiles at enemy tanks from a distance of miles. Most times the Iraqis were not aware of the source of the missiles destroying their tanks. In closer combat, the Apache's 70mm rockets and 30mm guns were formidable.

Helicopters have found more and more military applications through the years and have become essential to many types of military operations.

John L. Bell

See also

Gavin, James; Howze, Hamilton Hawkins

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Henschel Aircraft

German aircraft manufacturer; originated with the 1848 Henschel und Sohn concern, a major world manufacturer of railway locomotives that subsequently added trucks, buses, and machine tools to its product line. Henschel first considered entering aviation in 1931, when it negotiated to take over troubled Junkers, but in 1932 announced its own aviation subsidiary.

Henschel Flugzeugwerke AG was created in March 1933, based initially at Berlin-Hohannisthal but moving two years later to the larger Berlin-Schönefeld. It planned to manufacture other companies' designs under license and built the Ju 86D and Do 17 and later the important Ju 88. In 1936, Henschel established an aviation engine subsidiary as a Daimler Benz licensee and eventually built multiple factory locations.

Henschel's own designs were less successful, though two reached volume production. Its Hs 123 biplane dive-bomber was ordered in 1936 and tested in Spain in 1937. It became Germany's last operational biplane when used as a ground attack bomber in Poland, France, and Russia in 1939–1941.

The Hs 126 parasol-wing monoplane spotter aircraft was widely used, later as a trainer and for glider-towing; nearly 600 were built. The Hs 129 antitank and close support aircraft, with its triangular fuselage, was the firm's most successful model (860 manufactured). Yet six years of effort (1938–1944) on the Hs 130 high-altitude bomber proved fruitless. The Hs 132 single-engine dive-bomber jet was captured by the Russians prior to its first flight. The firm also manufactured guided air-to-surface missiles.

Henschel was restarted in 1954, again focusing on railway work and based at Kassel. Henschel joined Nordflug in 1955 to build the Noratlas transport. Though it purchased licenses to make Sikorsky helicopters, control of the company was sold to VFW in 1969.

Christopher H. Sterling

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HERCULES (1942)

German-Italian code name for the invasion of Malta that would have curtailed British interdiction of Axis supply lines from Italy to Libya.

Italian dictator Benito Mussolini long coveted Malta, and invasion planning began in 1935. The Italian navy refused to invade in 1940 or 1941 due to exaggerated views of Malta's defenses and unwillingness to risk ships. Hitler considered the Mediterranean a secondary theater and hesitated to employ airborne forces after the near-disaster on Crete. In 1941, rather than invade, he ordered air attacks to suppress British forces.

Preparation for HERCULES began in early 1942. Luftwaffe units flew 11,500 sorties in March and April, dropping some 7,200 tons of bombs and using carpet-bombing (for the first time ever) and rocket-propelled bombs to penetrate fortifications. The prerequisites for HERCULES were met: British air and naval power on Malta were neutralized, and no British fleet was available in the Mediterranean to respond. Mussolini met Hitler on April 30 and urged immediate invasion. Hitler, however, preferred to preempt British offensive preparations in Cyrenaica before assaulting Malta. HERCULES was postponed until July, and Luftwaffe units in Sicily moved to Africa to assist Afrika Korps commander Erwin Rommel.

In June, Rommel's Tobruk victory created a dilemma: Malta or Egypt? Mussolini argued for Malta. Hitler thought that the Italian Navy might flee, stranding German airborne troops on Malta, and wanted to invade Egypt before British reinforcements arrived. HERCULES was shelved again, and British forces on Malta soon resumed harassing Rommel's supply lines.

HERCULES would have employed one German and two Italian airborne divisions, six Italian infantry divisions arriving by sea, 500 Ju 52 transports, 500 gliders, captured Russian tanks, 200 landing craft, and Italian naval support. More than 100,000 invaders would have confronted 30,000 defenders. German and Italian airborne divisions would have seized the Luqa airfields, where another Italian airborne division would have reinforced. Italian infantry would have taken the Valetta beaches and made a diversionary attack on Marsa Scirocco. Finally, airborne and amphibious forces would have combined to capture Valetta.

Malta's topography favored the defenders. The coast was mainly cliffs, with very few beaches suitable for invasion. The countryside was divided into small fields surrounded by stone walls—perfect obstacles to gliders. Rocky terrain concealed many natural and man-made fortifications. HERCULES would not have been easy but probably would have succeeded. If executed in 1940 or 1941, it might have had a major strategic impact. In 1942, however, HERCULES could only have delayed the inevitable Axis defeat in North Africa that resulted from the Allies' Operation TORCH.

James D. Perry

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Herrman, Hajo (1913–)

German airman during World War II. Herrmann was born in Kiel on 1 August 1913. He volunteered for the new German air force (Luftwaffe) in August 1935 and was trained as a pilot of transport planes and bombers. From August 1936 to April 1937, he served with the Kondor Legion in the Spanish civil war, mainly flying transports. He participated in the Polish, Norwegian, and French campaigns in 1939–1940, flying Heinkel He 111s in Kampgeschwader 4.

Herrmann also flew bombing and antishipping missions against England in the fall of 1940, having been transferred to Kampgeschwader 30, which was equipped with the Junkers Ju 88 bomber. On 13 October 1940, while still a first lieutenant, he was awarded the Knight's Cross.

Being one of the brightest and most imaginative pilots, Hermann was always entrusted with the most difficult tasks. As a captain and squadron leader, he continued bombing and antishipping strikes against Malta, Greece, and North Africa in the spring of 1941. After two months of staff work with IX Air Corps, and now commander of a bomber group, he flew antishipping and other missions against Britain, the Allied Arctic convoys, and the Murmansk railroad from July 1941 to July 1942.

He was then transferred to the Technical Group of the Luftwaffe General Staff and later became General of Bombers, where he was responsible for tactical and technical requirements for aircraft and frequently participated in the conferences of the director-general of air armament. New insights into the general air war situation were possible at this level, and his contacts with the intelligence department of the Luftwaffe General Staff convinced him that fighter production should henceforth have priority over the bombers because Germany was on the defensive. This earned Hermann—the bomber pilot—the contempt of his comrades and the distrust of fighter pilots. Nonetheless, he maintained his opinion.

In the meantime, the radar-based German fighter defense system was always oversaturated and nearly invalidated by the bomber streams and by the new electronic countermeasures systems, including Window (chaff). On 27 June 1943, Hermann proposed to the commander in chief of the Luftwaffe, Hermann Goering, that night-fighter defense tactics be modified to a radical new scheme. This was the so-called Wild Boar plan that allowed the concentration of masses of single-engine day-fighters against the bomber streams independent of radar guidance. By using searchlights and flares for illumination and direction-finding, and by exploiting the fact that the bombers could easily be recognized against the clouds over burning cities, the fighters could make contact without radar.

The new tactics required boldness because the German antiaircraft artillery were already firing at the bombers, but it proved very successful as a last resort after German radar was blindfolded by Window as of 25 July 1943. On the basis of this success, Hermann was ordered to establish the "Wild Boar" Fighter Geschwader 300. He later became commander of this unit and of the 1st Fighter Division.

Still a major, he received the Oak Leaves to the Knight's Cross on 2 August 1943 and the Swords to the Oak Leaves on 23 January 1944 as a full colonel.

Hermann was behind the diversion of the pilots of the dwindling bomber force to the fighter arm. The bomber pilots were capable of instrument flying while the fighter pilots, lacking experience in instrument flight, suffered heavy casualties when the weather was poor.

In January 1945, Reichsmarschall Goering wanted Hermann, now famous as a specialist in emergency solutions, to become General of Fighters, replacing Adolf Galland. Strong opposition from the fighter force made Goering drop this plan. Galland and his backers had long supported the idea of the "Big Blow," in which single-engine fighters would be carefully saved until a large enough force could be assembled to do immense damage to inbound Allied bomber formations. Ram attacks became a feature of this idea. Pilots volunteered for what was essentially a suicide mission because they were patriotic and wished to stop the terrible bombing of their country. (Some may have volunteered in order to avoid being transferred to an infantry unit.)

Under Hermann, commander of the 9th Fighter Division, a special ram fighter force (Sonderkommando Elbe) was set up in the late winter of 1944–1945. It carried out its only mass attack on 7 April 1945, with negligible results and heavy losses.

Hermann was credited with 320 combat missions as a bomber pilot and 50 missions as a fighter pilot. As a bomber pilot he sank 12 ships of 65,000 gross register tons, and as a fighter pilot he gained nine victories over four-engine bombers. After the war he spent 10 years in Soviet prisons and POW camps, before being released on 12 October 1955. He later studied law and became a successful attorney in Düsseldorf in 1965. Hermann married, had two sons, and continued to pursue sport flying.

Horst H. Boog

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Hess, Rudolph (1894–1987)

High-ranking Nazi official who in May 1941 undertook a controversial mission seeking peace between Germany and Britain. He had joined the Nazi Party in 1920, soon became Adolf Hitler's personal secretary, and was made deputy party leader when the Nazis reached power in 1933. Apparently distressed by the war against Britain, feeling that the two countries had common cause against the Soviet Union, and seeing his own role declining in Germany, Hess took action. After three prior failed attempts, on 10 May 1941 he piloted an Me 110 twin-engine fighter aircraft from Berlin and bailed out over a field near Glasgow, Scotland. He sought to meet with the 14th Duke of Hamilton (a wing commander in the RAF whom Hess had not met) to offer the British peace terms to end their role in the war before Germany invaded Russia (which took place the next month).

Whether Hitler knew of Hess's plans beforehand is not clear, though it seems unlikely on the available evidence. The British imprisoned Hess for life on two of four counts at the Nuremberg war-crimes trials in 1946. Hess was incarcerated at Spandau in Berlin, where he committed suicide in 1987 at age 92. His 1941 mission and subsequent imprisonment remains shrouded in mystery, and conspiracy theories abound.

Christopher H. Sterling

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Hiroshima

Site of the first wartime atomic bombing, by the United States on 6 August 1945. Japan's eighth largest city at the time, with a population of more than 350,000. Hiroshima is located at the mouth of the Ota River on southwestern Honshu Island. An important manufacturing center with shipyards, textile plants, and other industries, the city was also headquarters of the Fifty-Ninth Japanese Army.

On the morning of the attack, the city center was teeming with people on their way to work. Among them were more than 8,000 conscripted high school students who were demolishing buildings to create firebreaks as a defense against expected incendiary bombardments. At 7:09 A.M. the city's civil defense administration sounded an air-raid warning. A single B-29 weather aircraft had appeared over the city to measure conditions. It reported temperatures of 26 degrees Celsius and a humidity of 80 percent. At 8:15 A.M. the USAAF B-29 Superfortress *Enola Gay,* under the command of Colonel Paul W. Tibbets, dropped an atomic bomb (codenamed "Little Boy") at an altitude of 9,600 meters.

The bomb was a gun-assembled uranium (U-235) device. Two pieces of U-235 were shot against each other. When they met they formed a critical mass and produced a fission reaction and ultimately a chain reaction. The energy that was produced in this process created heat and radiation.

At 570 meters, 43 seconds after release, the bomb detonated, producing an explosive power equivalent to 14,000 tons of TNT. The epicenter immediately reached a maximum temperature of several million degrees Centigrade. Atmospheric pressure exceeded 300 bars. The busy city center, with its packed trams and buses, was now an inferno. Firestorms, blasts, shockwaves, burning houses, charred corpses, and blinded bodies tried to escape the hellfire. The city was flattened over an area of 13 square kilometers. Some 70,000 of 76,000 buildings were destroyed or seriously damaged. Nine out of 10 people in a radius of 1,000 meters from the epicenter were killed instantaneously.

Although casualty figures became an important battleground in the emotionally charged postwar debate over the legitimacy of the bombings, conservative estimates count approximately 130,000 people dead and the same number wounded. An additional 70,000 people died by 1950 of radiation illness, and 81 percent of the city had been destroyed.

The attack has become embedded in a complex web of memories and interpretations. During the Cold War, Hiroshima became a semimythic symbol for the nuclear menace, a visible reminder of the potentially disastrous consequences of the arms race. In the post–Cold War world, Hiroshima has become a contested memory. The emotional public debate on the plans of the Smithsonian Institution's Air and Space Museum to publicly display the *Enola Gay* in 1995 as part of an exhibit commemorating the fiftieth anniversary of the end of World War II amply demonstrated how national and collective identities in Japan and the United States are still shaped by the bombing of Hiroshima.

Frank Schumacher

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Ho Chi Minh Trail

An elaborate system of mountain and jungle paths and trails used by North Vietnam to infiltrate troops and supplies into South Vietnam, Cambodia, and Laos during the Vietnam War. Using a 30,000-man workforce, construction began in May 1959 to connect a series of old trails leading from the panhandle of North Vietnam southward along the upper slopes of the Annamese Cordillera into eastern Laos and Cambodia and thence to South Vietnam. Starting south of Hanoi in North Vietnam, the main trail veered southwestward to enter Laos, with periodic side branches running east into South Vietnam. The main trail continued southward into eastern Cambodia and then emptied into South Vietnam at points west of Da Lat. Spurs were also constructed off the main trail into base areas, such as the A Shau Valley in I Corps and into War Zone C in III Corps.

The network of trails and volume of traffic significantly expanded in the 1960s, but it still took more than a month to march from North to South Vietnam. U.S. aircraft repeatedly bombed the trail during Operations STEEL TIGER, TIGER HOUND, and COMMANDO HUNT.

Although the flow of men and supplies from North Vietnam was slowed and North Vietnam was forced to divert enormous assets into keeping the route repaired, airpower was never able to close the Ho Chi Minh Trail completely.

The trail was continually improved and by the late 1960s could accommodate heavy trucks and was supplying the needs of several hundred thousand regular North Vietnamese troops active in South Vietnam. By 1974, the trail was a well-marked series of jungle roads (some of them paved) and underground support facilities such as hospitals, fuel-storage tanks, and weapons and supply caches. The Ho Chi Minh Trail was the major supply route for the North Vietnamese forces that successfully invaded and overran South Vietnam in 1975.

James H. Willbanks

See also

ARC LIGHT; Cambodia Bombings; COMMANDO HUNT; ROLLING THUNDER; STEEL TIGER

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Holloway, Bruce K. (1912–1999)

Remembered as commander in chief of Strategic Air Command from 29 July 1968 through 1 May 1972. Under Holloway's command, SAC faced an increasingly divided role: tactical bombardment and aerial refueling in Southeast Asia versus its primary mission of strategic nuclear warfare as part of the early evolution of détente. Holloway was a strong champion of SAC's nuclear role and worked successfully to minimize the number of SAC aircraft sent to Southeast Asia.

Holloway's early years are less well known but equally illustrious. Beginning in January 1942, he flew Curtiss P-40s as part of the famed Flying Tigers. A year later he replaced Robert L. Scott as commander of the 23d Fighter Group. During his tenure with the Flying Tigers, Holloway shot down 13 Japanese aircraft. He went on to serve in a number of leadership roles throughout his career, including commander of the U.S. Air Forces, Europe, and as USAF vice Chief of Staff. General Holloway retired in 1972.

Robert S. Hopkins

See also

American Volunteer Group; ARC LIGHT; Cold War; Strategic Air Command; Vietnam War

Horikoshi, Jiro (1903–1982)

Creator of the Mitsubishi A6M Zero fighter. Jiro Horikoshi was born in 1903 in Fujioka, Grunma Prefecture, Japan. His interest in aircraft began in grade school while he was reading newspaper accounts of the air war in Europe. During his senior year in high school he was faced with the decision of what to study when he graduated. He decided on aeronautical engineering and in April 1923 began his studies in the newly formed Aeronautics Department at the University of Tokyo.

In 1926, Jiro joined Mitsubishi as an engineer in the airframe design section. Jiro's first major design project was the Prototype 7, a navy monoplane fighter. The project was part of a prototype competition that the Japanese used to select new aircraft. Both Prototype 7 aircraft built for the competition crashed during flight-testing. It was a rather inauspicious start for Jiro—but one that gained him a great deal of experience.

Jiro's next project was the Prototype 9 or Type 96 No. 1 carrier-based fighter. This aircraft, the A5M, was known to the Allies as "Claude," a top performer during its time. It was very fast and had excellent handling characteristics, which pilots particularly favored.

When the specifications for the Prototype 12 aircraft came to Mitsubishi in 1937, Jiro was once again called upon to lead the development. The Prototype 12 would become the Mitsubishi Type Zero carrier-based fighter, Model 11. The Zero would be the backbone of the Imperial Japanese Navy from 1940 to 1945.

While Jiro completed work on the Zero he was also tasked to produce a new aircraft the Prototype 14, the J2M Raiden ("Jack" to the Allies). The Raiden was an interceptor, used with very limited success against U.S. B-29 raids.

Jiro's final design was in progress when the war ended. It was the A7M Reppu ("Sam" to the Allies), in flight-testing when the war came to an end.

David A. Pluth

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Horner, Charles A. (1936–)

U.S. Air Force general. Charles A. "Chuck" Horner was born on 19 October 1936. Upon graduating from the University of Iowa, he was commissioned an officer in the United States Air Force and completed pilot training in 1959. During the Vietnam War, he flew more than 110 combat missions in F-105 Thunderchief and Wild Weasel aircraft and went on to command two fighter wings, two air divisions, the Ninth Air Force, and U.S. Space Command.

As commander of U.S. Central Command Air Forces in 1990, he was designated the overall air component commander during the Gulf War. As such, he orchestrated and led the highly successful Coalition air campaign against Iraq from August 1990 to April 1991. Horner was subsequently advanced to four-star rank and given command of all U.S. military space resources. He retired from active duty in September 1994.

Paul G. Gillespie

See also
DESERT SHIELD; DESERT STORM; Gulf War

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Horten Flying Wings

Unique German aircraft that used the flying-wing concept. German engineers Walter, Reimar, and Wolfram Horten were designers and builders of flying-wing aircraft, beginning with gliders, from the end of the 1920s to the late 1940s. (Wolfram was killed in combat in 1940, Reimar died in 1993, and Walter died in 1998.) Their first manned glider, the Ho 1, designed in 1931, flew in 1933. A series of gliders were designed and flown to evaluate various configurations and structures, culminating in five models built for powered flight—the Ho V, Ho VII, Ho VIII, Ho IX, and Ho XII.

The Ho V, built in 1937, was powered by two Hirth HM60R 80-shp engines and was the first Horten aircraft to demonstrate commercial or military potential. (However, the first actual military use of Horten aircraft was when several Ho IIs and IIIs were converted to freight-carrying for demonstration of capability to carry materials across the English Channel.) Two Ho Vs flew, both with two seats, one of mainly plastic, using sheet, sandwich, and laminate, the other a plywood-covered steel-tube-center structure and wooden outer wing panels. A crash of the first version demonstrated that the brittleness of the plastic made it an unsuitable material. The second version was rebuilt with a single seat for an upright pilot versus the prone pilot cockpit for the first version and some previous Horten aircraft.

The Ho VII, designed as a trainer for pilots flying all-wing aircraft, was a scale-up of the Ho V, being powered by two Argus AS-10-C 240-shp engines. Three were ordered, but only one was completed; it flew in May 1943. A production contract for 20 Ho Vs was received in 1944, but none had been delivered by war's end.

The Ho VIII was a 1942 conceptual design for a 158-foot-span all-wing transport to be powered by six Argus AS-10-C engines with pusher propellers, a payload of 60 passengers, and a range of 3,700 miles. It began construction in autumn 1944 as an aerodynamic testbed for the planned Horten Ho XVIII "Amerika Bomber."

The Ho IX was conceived as a fighter-bomber, with wooden wings and a welded-steel-tube structure (all plywood-covered) with jet engines. The Hortens had been aware of jet engine development, and the concept of the Ho IX was stimulated by witnessing a flight of the Me 163 in August 1941. Starting in early 1942, concepts were designed around the Bramo/BMW P3302 engine, then the smallest-diameter engine available. Construction started in June 1942. When the Hortens were advised in late 1942 that the P3302 engine had been canceled, they selected the BMW 003 as the next-best. Its larger diameter necessitated redesign of the already-started center structure. In early 1943, an opportunity arose to propose the Ho IX design to meet a requirement for an aircraft to carry a 1,000-kilogram bomb 1,000 kilometers at 1000 kph, which they did, receiving contract coverage in August 1943 for two prototypes (V1 and V2).

About this time, Horten was advised that the BMW 003 was not going to be qualified when expected and that the Jumo 004 would have to be used. It was decided to complete the V1 as a glider with fixed landing gear so as to quickly gain flight experience. The V2 was started shortly after the V1, and its center section was also redesigned for the BMW 003, but the existing structure was not reworked for the Jumo 004, as no change in size was expected. However, Jumo 004 engines were not obtained until March 1944 and were 20 centimeters greater in diameter than anticipated because the accessory section had been changed.

The Hortens were not receiving official communications on engine status because sometime before engine delivery their contract had been canceled by the Reich Air Ministry. From that time, the Ho IX's continuing development was unique in being "bootlegged" from government funds without official sanction. Because of the delay caused by having to switch to the Jumo 004 engine, the V2 did not fly until 18 December 1944, seven months later than it would have had the BMW 003 been available. The V2 crashed on its third flight on 18 February 1945; however, by this time Gotha had been contracted to develop the production version (Go 229) and further redesigned the engine installation. Several Gotha prototypes were nearing completion when the war ended.

The Ho XII was a primary trainer built without contract coverage, designed and built for a six-cylinder DKW engine, that flew without the engine in December 1944. There was no production.

On 12 March 1945, the Hortens received a contract for the Ho XVIII, a four-jet long-range all-wing bomber. After the war, the Ho XVIII design was revised as a piston engine–driven transport, with no success. In 1948, Reimar Horten emigrated to Argentina and there designed the IA.38, about two-thirds the size of the Ho VIII, powered by four 450-shp engines, with a payload of 6 tons.

Douglas G. Culy

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Howard, James Howell (1913–1995)

World War II double-ace, Medal of Honor winner, and USAF brigadier general. Born in Canton, China, on 8 April 1913, James Howell Howard died in Bay Pines, Florida, on 18 March 1995. After graduation from Pomona College in 1937, Howard became a naval aviator. He returned to China to join the American Volunteer Group—the Flying Tigers—under Claire Chennault. In the Flying Tigers, Howard flew P-40s against Japanese Zeros, I 97s, and Nakajima Ki 27s. In 56 missions, he destroyed six opponents and became an ace over Burma and China.

After the Flying Tigers disbanded, Howard went to Boxted, England, with the 354th Fighter Group of the Ninth Army Air Force. The 354th flew P-51s that replaced P-38s and P-47s to defend B-17s and B-24s on bombing missions over Germany. German opponents flew Messerschmitt Bf 109s and Bf 110s, Focke-Wulf Fw 190s, and Junkers Ju 88s. During a mission on 11 January 1944, Howard single-handedly defended 30 B-17s against 30 German fighters. He shot down four opponents and scared others away. All 30 B-17s survived. Consequently, Howard received the Congressional Medal of Honor—the only European theater pilot to do so—and eventually became an ace over Europe. Howard retired from the Air Force Reserve in 1966.

Gary Mason Church

See also

American Volunteer Group; Boeing B-17 Flying Fortress; Burma; Chennault, Claire L.; Consolidated B-24 Liberator; Curtiss P-40 Warhawk; Focke-Wulf Fw 190; Germany, and World War II Air Battles; Junkers Ju 52/3m, Ju 87 Stuka, and Ju 88; Lockheed P-38 Lightning; Messerschmitt Bf 109; Nakajima Aircraft; North American P-51 Mustang; Republic P-47 Thunderbolt; United States Army Aviation

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Howze, Hamilton Hawkins (1908–1998)

U S. general who led the Army to adapt aviation to combat. As an armor commander in North Africa and Italy in World War II, Howze chafed at his troops' lack of mobility in mountainous terrain. After the war he advocated using helicopters in combat to increase Army mobility.

From 1955 to 1958, Howze served as the first director of Army aviation under General James Gavin. In this position Howze did many things. He tried to persuade the Army to use helicopters to solve tactical problems studied in Army schools. Establishing a program for senior officers to become pilots, he sold them on aviation and gained adherents to his views. Howze intervened with the Air Force to save the UH-1 program and the Huey as the Army's future combat helicopter. He also named aircraft after American Indian tribes and publicized the capabilities of helicopters in public demonstrations. The enlargement of pilot training and aviation support facilities were also major concerns.

Howze's leadership resulted in the greater acceptance and experimentation with aviation within the Army, but he went farther. In 1960, he served on the Rogers Board and recommended the creation of air cavalry units mounted in helicopters. His advocacy of air cavalry resulted in his appointment in 1962 as president of the Tactical Mobility Requirements Board at Fort Bragg. The so-called Howze Board tested many air assault concepts and found them feasible. Its work led in 1963 to the creation of the 11th Air Assault Division (Test) that refined many of the Howze Board's concepts. The need for a highly mobile force in Vietnam in 1965 led to the conversion of the 11th Air Assault Division into the 1st Air Cavalry Division, which did excellent service in Vietnam and validated the revolutionary ideas of Howze and his mentor James Gavin.

John L. Bell

See also

Gavin, James; Howze, Hamilton Hawkins

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Hump Airlift

World War II air route over the Himalayas between India and China. The Hump was first surveyed in November 1940 by the China National Aviation Corporation (CNAC), a Sino-American airline, as a possible air-freight link to China in the event that the Burma Road was severed. Although the hazards of flying over the Santsung Range, where mountain peaks reached to 15,000 feet, were recognized, officials of the airline believed that the route could be operated if the situation became desperate.

In the spring of 1942, the fall of Rangoon and Japanese advances into northern Burma closed the Burma Road. As President Franklin D. Roosevelt declared in May 1942 that routes to China must be kept open, the Army Air Forces had no choice but to attempt the challenging mountainous airlift.

Operations over the Hump began in the late spring of 1942 with Douglas transports from CNAC and the Tenth Air Force flying from Dinjan in Assam Province, India, to Kunming, China, a distance of 500 miles. Progress in developing the route came slowly and painfully, with a limited number of aircraft and crews being pushed to their operational limits.

On 1 December 1942, the Air Transport Command (ATC) took over responsibility for the Hump route from the Tenth Air Force. Colonel Edward H. Alexander brought a new spirit to the enterprise, but operational difficulties and Japanese air action continued to plague the airlift. By July 1943, monthly tonnage from India to China stood at 3,451 tons, less than half the amount that President Roosevelt was demanding. A reorganization is September 1943 saw Brigadier General Earl Hogg assume command of the India-China Wing of the ATC with Colonel Thomas O. Hardin in charge of the airlift.

Tonnage increased under the hard-driving leadership of Hardin, who instituted night-time operations over the route. By December 1943, ATC was carrying 12,000 tons a month to China. The cost, however, proved high. Between June and December 1943, 135 aircraft and 168 airmen fell victim to enemy fighters, bad weather, and treacherous terrain.

Beyond the staggering operational problems, the need to divert Hump tonnage to other tasks frequently meant that materiel destined for the Chinese fell short of expectations. For example, the use of B-29s to bomb Japan from bases in China consumed 30,000 tons of precious cargo during 1944. Nonetheless, thanks to more and better aircraft, especially C-46s, Hump tonnage rose to 23,675 in August 1944.

In September 1944, Brigadier General William H. Tunner replaced Hardin. Destined to become the Air Force's premier airlifter, Tunner soon had the route operating with impressive efficiency. By the end of the year, 30,000 tons a month were being carried to China. Tunner believed that virtually any amount of cargo could be flown over the Hump if he had the requisite facilities and men.

By the end of the war, 650,000 tons of vital supplies had been carried from India to China, with more than half the total being flown during the first nine months of 1945. No doubt, this materiel played a vital role in keeping China in the war and tying up large numbers of Japanese troops. The experience also provided the Air Force with a solid foundation for future airlift operations during the Berlin crisis of 1948–1949 and the Korean War.

William M. Leary

See also

Tunner, William H.

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Hunsaker, Jerome Clarke (1886–1984)

U.S. pioneer in aeronautical engineering. Jerome C. Hunsaker was born in Creston, Iowa, on 26 August 1886. He graduated from the U.S. Naval Academy in 1908 and received advanced degrees in naval architecture and mechanical engineering from MIT. In 1913, he translated Gustave Eiffel's *The Resistance of the Air and Aviation* and a year later established one of the nation's first aeronautical engineering programs at MIT. He became a proponent of engineering science, committed to the concept that scientific theories could inform engineering practice.

During and after World War I, he was responsible for the Navy's airplane and airship design and procurement and later served as an assistant naval attaché in London and Paris. After leaving the Navy in 1926, he developed a weather-reporting and airway-navigation system for Bell Labs, and as vice-president of the Goodyear-Zeppelin Corporation he proposed the establishment of commercial airship lines. In 1933, he returned to MIT as head of the Department of Mechanical Engineering and later was in charge of the new Department of Aeronautical Engineering.

In 1941, Hunsaker became chairman of the National Advisory Committee for Aeronautics (NACA). He encouraged NACA to become more active in the development of aircraft power plants, established new laboratories, and moved the organization in the direction of basic research. After the war, Hunsaker was the chief proponent of the civilian-government "unitary" wind-tunnel program. He resigned as chair of NACA in 1956 on the eve of the space age. In retirement, Hunsaker remained active as a technical consultant and was a member of numerous federal aviation committees and investigatory boards. He died in Boston on 10 September 1984 at the age of 98.

William F. Trimble

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HUSKY (1943)

Allied code name for the invasion of Sicily during World War II. Plans drawn up in Cairo on 18 March 1943 called for teaming the Ninth and Twelfth Air Forces in North Africa to make combined attacks on the Italian island. With the fall of Tunisia in early May, heavy bombers turned their attention toward Sicily. Some 4,000 sorties were flown against airfields by aircraft from the North African Air Forces for eight days prior to the invasion. Axis resistance resulted in the loss of 139 of their aircraft.

The invasion was 10 July 1943. A force of 160,000 men, aboard an armada of some 2,000 ships, departed ports in Tunisia, Tripoli, Tobruk, and Egypt and steamed toward Sicily. The seaborne landings began at 2:45 A.M.

During the night of 9–10 July, two airborne assaults were executed—the first Allied parachute assault in the war. Some 1,600 British paratroops from the 1st Airborne Division were brought to battle aboard gliders towed by 133 C-47s from the USAAF's 51st Troop Carrier Wing (51st TCW). Although no tow planes were lost, 12 gliders crashed in the landing zone, 47 ditched in the sea, and the remainder were scattered about the island.

The second airborne assault was made by the U.S. 82d Airborne Division using 226 C-47s. The aircraft, from the 52d TCW, dropped 2,781 paratroops and 891 parapacks. Their objective was to seize enemy airfields. Unfortunately, their landings were scattered, causing them to alter plans and operate against communications targets.

Approximately 4,000 aircraft from the RAF and the Ninth and Twelfth Air Forces flew against targets in Sicily on 9–10 July, rendering Axis airpower virtually helpless.

A major enemy counterattack was mounted against the U.S. forces near Gela. A third airborne assault was launched on the night of 11 July. A force of 2,300 paratroops from the 504th Parachute Regiment were brought to battle aboard C-47s from the 52d TCW. The Army generals advised the ground forces on the island of the airdrop. The Navy assured that it would obtain antiaircraft-free passage for the planes. The approach was flown over the Navy task force that had not been informed of the new airdrop. Hence, the formations of C-47s met with withering antiaircraft fire from the ships. Some of the aircraft had to make two or three passes over the drop zone to get the paratroops in. Of the 154 C-47s on this mission, 23 were shot down. More than half of the returning planes were severely damaged.

On the night of 13 July, the 51st TCW was tasked with bringing in a force of British paratroops to take a bridge near Catinia. Once again, the Navy had not been informed, and 11 of the 124 C-47s were shot down by friendly fire; another 50 were damaged. In the debacle, 27 aircraft returned to base with full or partial loads.

A major investigation was initiated at the behest of General Dwight D. Eisenhower. RAF Air Marshall Arthur Tedder added his comments to the report, stating that antiaircraft fire at night is ineffectual and almost uncontrollable. Lessons learned from Operation HUSKY were taken into account for Operation OVERLORD, the June 1944 cross-Channel invasion of the European continent.

Late in the campaign, the USAAF introduced Rover Joe, an early forward air controller who called in coordinated air strikes in support of ground operations.

Alwyn T. Lloyd

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Hutton, Carl Irven (1907–1966)

U.S. Army brigadier general. Hutton played a pivotal role in the development of the armed helicopter. Born in Terre Haute, Indiana, he graduated from West Point in 1930 and served in various field artillery and quartermaster assignments during the next decade. A distinguished record in World War II culminated with his command of the 2d Armored Division Artillery during the campaigns in France and Germany. A pilot and light plane owner before the war, he became an enthusiastic supporter of field artillery organic aircraft in combat.

Following the war, Hutton earned his liaison pilot wings and then served as director of the Department of Air Training at the Field Artillery School from 1947 to 1949. Promoted to brigadier general in 1953 while commanding the 24th Infantry Division Artillery in Korea, he became commandant and commander of the recently established Army Aviation School and Center at Fort Rucker, Alabama, in August 1954, a post he held for three years. He initiated and vigorously supported Colonel Jay D. Vanderpool's experiments with armed helicopters even in the face of skepticism by the Army Chief of Staff, General Maxwell D. Taylor. Hutton retired in 1961.

Hutton had a blunt, take-no-prisoners style that hid a discerning intellect and a deep interest in military history. One of several officers in the mid-1950s who recognized the need for an armed helicopter, he was the one with the authority and moral courage to initiate the experiments, take the inevitable criticism, and defend the program. Without him, the development of an airmobile division in the 1960s was simply inconceivable.

Edgar F. Raines Jr.

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I

Ia Drang Valley, Battle of (1965)

The first major engagement of the war between regular U.S. and North Vietnamese forces. In this action, elements of the 3d Brigade, 1st Cavalry Division (Airmobile), fought a pitched battle with communist main-force units in the Ia Drang Valley of the Central Highlands.

On the morning of 14 November 1965, Lieutenant Colonel Harold G. Moore's 1st Battalion, 7th Cavalry, conducted a heliborne assault into Landing Zone X-Ray near the Chu Pong Hills. The 1st Cavalry troopers soon found themselves in a desperate three-day battle with two North Vietnamese regiments. The fighting was bitter, but tactical air strikes and artillery support took their toll on the enemy, and Moore's soldiers held against repeated communist assaults. Another key factor were the ARC LIGHT B-52 missions that were flown in direct support of U.S. ground troops in contact for the first time.

By the third day of the battle, the Americans, having been reinforced and supported, had gained the upper hand. The battle resulted in 834 North Vietnamese soldiers confirmed killed, and it was believed that another 1,000 communist casualties were likely. In a related action during the same battle, 2d Battalion, 7th Cavalry, was ambushed by North Vietnamese forces as it moved overland to Landing Zone Albany. Of the 500 men in the original column, 150 were killed and only 84 were able to return to immediate duty; Company C suffered 93 percent casualties, half of them deaths. Despite these casualties, senior U.S. officials in Saigon declared the Battle of the Ia Drang Valley a great victory.

The battle was extremely important, because it was the first significant contact between U.S. troops and North Vietnamese forces. The action demonstrated that the North Vietnamese were prepared to stand and fight major battles when they so chose, even though they would take serious casualties. Senior U.S. military leaders concluded that U.S. forces could inflict significant casualties on the communists in such set-piece battles and that this would lead to a war of attrition as U.S. forces tried to wear down the communists in massive search-and-destroy missions. The North Vietnamese also learned a valuable lesson during the battle: They saw that they could counter the effects of superior U.S. firepower through close-in fighting, which became their normal practice for the rest of the war.

James H. Willbanks

See also

ARC LIGHT

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Ilya Muromets

Russian World War I bomber. Aeronautical engineer Igor Sikorsky designed and built the world's first four-engine bomber by 1914. The aircraft had a wingspan of nearly 100 feet and weighed more than 10,000 pounds. The most advanced model had a range of 5 hours and a ceiling of more than 9,000 feet. It carried a bombload of 1,000–1,500 pounds and was equipped with up to seven machine guns. Four 150 horsepower Sunbeam V-8 engines allowed the bomber to cruise at 75–85 mph. The rear fuselage possessed sleeping compartments for a crew of five, a washroom, a small table, and openings for mechanics to climb out onto the wings to service the engines during flight.

More than 75 Ilya Murometses were deployed against the

Central Powers along the Eastern Front from 1915 to 1918. These aircraft conducted more than 400 bombing raids against targets in Germany and the Baltic nations. During the war, only one bomber was lost to enemy action. In February 1918, many Ilya Murometses were destroyed by the Russians to prevent capture by advancing German forces. A few of the bombers lingered on into the 1920s, flying under the new Soviet banner.

Mark E. Kahn

See also
Sikorsky, Igor I.; World War I Aviation

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Ilyushin Aircraft

Influential Russian aircraft designer and manufacturer. Sergei Vladimirovich Ilyushin (1894–1977) became involved in aviation during World War I and began designing aircraft after graduating from the Zhukovsky Military Aviation Engineering Academy in 1926. He spent his early career working to review aircraft designs and develop requirements for the nascent Red Air Force. Ilyushin began actual design work in earnest in the early 1930s in cooperation with other designers and finally as the head of his own bureau in 1936.

Ilyushin's DB-3/Il-4 medium bomber entered service in 1937 and served throughout World War II as a standard bomber and torpedo-bomber for both the air force and the navy. Ilyushin's most famous design, the Il-2 Shturmovik, was built in greater numbers than any other wartime aircraft. The Shturmovik was the bane of German troops and vehicles on Eastern Front battlefields. Ilyushin won the Hero of Social Labor Award for the Il-2 and, in 1945, won the Stalin Prize for the successor aircraft, the Il-10.

The Il-10 served in many Soviet satellite air forces following World War II, including those of the People's Republic of China and the Democratic People's Republic of Korea during the Korean War. Ilyushin's design bureau did not rest on its well-deserved wartime laurels but produced the Soviet Union's first jet bomber, the Il-28, and a series of transport and commercial aircraft. The twin-engine Il-28 first flew in 1948 and soon became a staple in many of the world's air forces. These aircraft were part of the air defense system that the Soviet Union installed in Cuba precipitating the Cuban Missile Crisis in 1962. The People's Liberation Army Air Force is only now clearing its inventories of its license-built version, the Hong-5.

Ilyushin's transport aircraft still provide much of the strategic mobility that the Russian military possess. The Il-62, Il-76, and Il-86 jet airliners have served with the Soviet and then Russian state airline, Aeroflot, since entering service in the 1970s. Although Ilyushin retired from design work in 1970 and died in 1977, his influence on Russian aviation continues.

Mark A. O'Neill

See also
Ilyushin Il-2 Shturmovik

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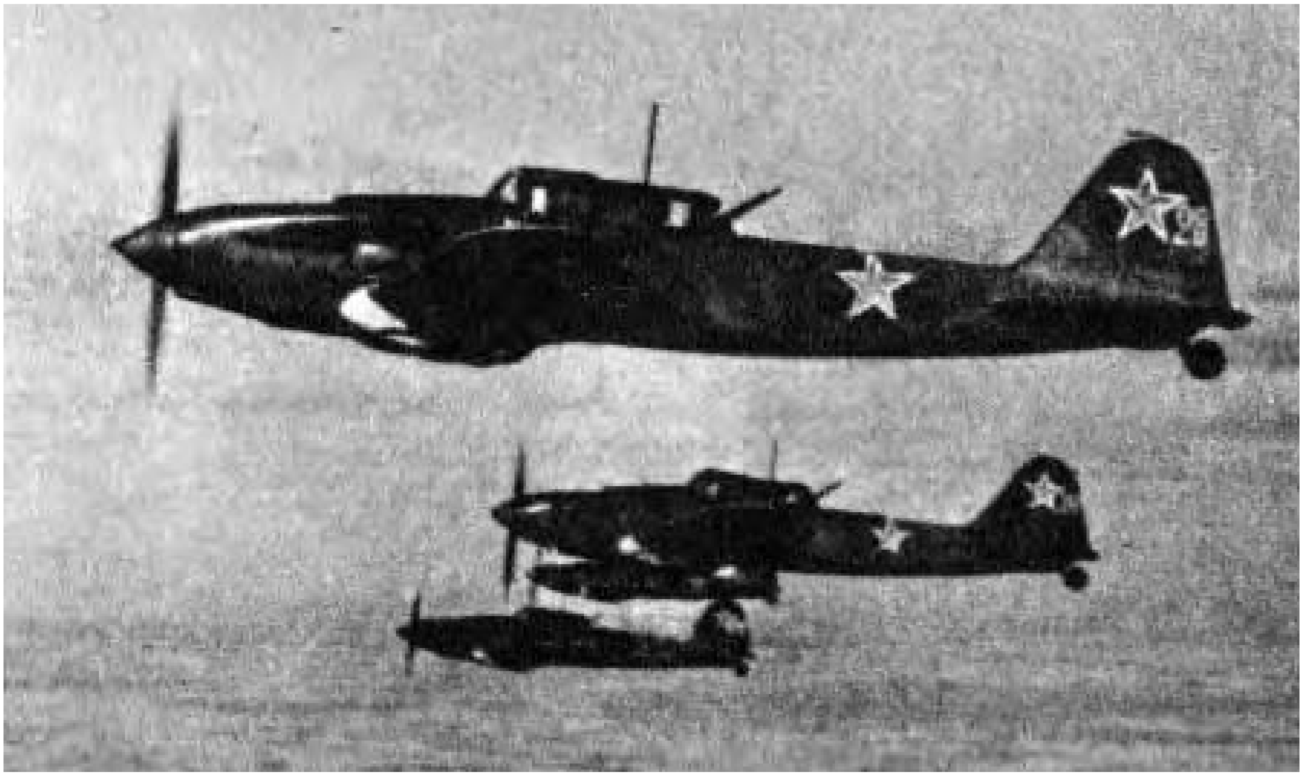
Ilyushin Il-2 Shturmovik

Soviet ground attacker aircraft. Sergei V. Ilyushin's greatest contribution to the success of the Red Army during World War II was the Il-2 Shturmovik. The Il-2, nicknamed "Schwartzer Todt" (Black Death) by the Germans, helped the Soviet military destroy the Wehrmacht during the massive ground battles on the Eastern Front from 1941 to 1945.

In 1937, Ilyushin began work on his self-designated "Flying Tank" without obtaining prior approval from Joseph Stalin. The Il-2 was remarkable because Ilyushin integrated an armored steel, nickel, and molybdenum shell into to the airframe that protected the crew, engine, and fuel system. He submitted his design directly to Stalin in early 1938 and began constructing prototypes in February 1939. Bureaucratic delays postponed production, but Ilyushin continued to test the aircraft at his own facilities. A new liquid-cooled AM-38 engine and cannons were added to increase the Il-2's speed and firepower. Il-2 production began in March 1941 and the aircraft entered service just prior to the 22 June 1941 German invasion of the Soviet Union.

The Shturmovik was one of a number of rude surprises that the Soviets had for the invading Wehrmacht, but the Il-2 was not available in large numbers and was vulnerable to fighter attack from the rear. Eventually, the Il-2 and the modernized Il-10 were produced in greater numbers than any other aircraft in World War II, with 36,000 Il-2s alone built for the air force and naval aviation. Operational ground attack units, such as the 198th Shturmovik Aviation Regiment,



Josef Stalin stated that the Ilyushin Il-2 was as important as bread and air to the Soviet army. It was produced in great numbers and became veritable flying artillery on the Eastern Front. (Jean Cottam)

began adding a rear-facing machine gun and gunner as a field modification by 1942. Factories began delivering the new two-seater Il-2s by the fall of 1942, which substantially reduced the numbers lost to Luftwaffe fighters.

Often operating in division-sized formations in air armies attached directly to Soviet fronts (the rough equivalent of army groups) and comprising as much as 30 percent of the entire Soviet air force inventory, this heavily armored single-engine aircraft extended Soviet firepower throughout the depth of the battlefield. Working with tanks, infantry, and artillery as part of a revolutionary combined arms team, the Il-2 and other ground attack aircraft destroyed enemy tanks, vehicles, and artillery in direct support of the Red Army. In order to accomplish this task, the Shturmovik was equipped with 23mm cannons, aerial rockets, bombs, and special antitank bomblets that burned their way through the thin roof and engine deck armor on German tanks and other vehicles.

The Shturmovik demonstrated its flexibility and utility during the siege of Stalingrad as it helped close the aerial blockade that ensured that the German Sixth Army could not be resupplied. By the Berlin operation of April 1945, the Il-2 was a vital part of the massive 7,500-plane Sixteenth Air Army. Ilyushin's design not only contributed to the Red Army's victory over Nazi Germany but also influenced aircraft design and tactics to the present day. The U.S. Air Force's A-10 Warthog is simply the modern equivalent of Ilyushin's Flying Tank.

Mark A. O'Neill

See also
Ilyushin Aircraft

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Imperial Russian Air Service

The Imperial Russian Air Service had its origin in the observation balloon units that were formed in 1885 and expanded after the Russo-Japanese War. In 1909, the czar's cousin, Grand Prince Mikhail Aleksandrovich Romanov, recognized the military implications of Louis Blériot's historic flight across the English Channel and began to promote aviation in Russia. As a result of his sponsorship, in 1910 both the army and the navy established flying services, with Grand Prince Mikhail himself commanding the Army Air Service. He bought aircraft abroad and promoted the founding of domestic aviation firms such as Dux, Grigorevich, RBVZ, Anatra, Lebedev, and Sikorsky.

During the next few years, flying became fashionable among the younger nobility and included a number of women pilots. One of these early female pilots, Princess Evgeniya Shakhovskaya, joined the air service in 1914 and became the world's first female combat pilot.

In contrast to its general image as backward and unprepared, Russia in August 1914 had the largest air force in the world, with some 250–300 aircraft and 11 airships. Germany, by contrast, had 230–246 aircraft and Austria only 35; France and Britain had 160 and 110 aircraft, respectively. Although historians have pointed out that most of Russia's aircraft were old and almost unflyable, the designs of other countries in 1914 were not much better.

Russia's real problem lay in its industrial infrastructure, which was totally inadequate to keep pace with the design and production of military aircraft, which evolved rapidly during World War I. Instead, Russia was soon reduced to purchasing outdated castoffs from Britain and France and trying to produce licensed copies, generally in inadequate numbers. There were two significant exceptions to this grim scene. The Grigorevich firm produced a series of small and medium flying boats that proved superior to the Germans' in combat over the eastern Baltic and Black Seas, and the Sikorsky factory designed and produced the world's first four-motor heavy bomber, the Ilya Muromets. During the war 93 Ilya Murometses were produced and flew 400 sorties, dropping 65 tons of bombs and proving almost indestructible to German fighters.

There were also difficulties finding adequate numbers of recruits capable of being trained as pilots and observers, as illiterate peasants still constituted more than 90 percent of the population. Still, the Imperial Russian Air Service was able to grow from about 40 detachments in 1914 to 135 detachments by the time Russia left the war.

During the war, 26 Russian pilots became aces, scoring a total of 188 air victories. Among them was leading ace Aleksandr Kozakov, but possibly the most significant was Captain Aleksandr Nikolaevich Prokofiev de Severskii, who scored six air victories as a naval pilot flying over the Baltic in 1916 after his leg had been amputated in 1915. After the Russian Revolution he emigrated to the United States, achieving fame as Alexander de Seversky. While the achievements of Russia's air aces seem paltry next to those of Germany, France, and Britain, we should remember that even over the Western Front aerial combat was a rarity until late 1915. Suitable fighting machines began to appear only in 1916, and almost all the leading Western aces scored the great majority of their victories in 1917 and 1918, by which time the Russians had already left the war. Further, the vast spaces of the Eastern Front and the fewer numbers of German and Austrian aircraft committed meant that contact between enemy aircraft occurred less often.

After the abdication of Nicholas II in February 1917, the army, and the air service in particular, continued fighting, and the air service even continued fighting briefly after the Bolshevik coup in November. However, as the army collapsed and ground crews went over to the communists, operations became impossible. Some of the noble pilots were lynched by revolutionary ground crews, and others either went over themselves or fled to areas controlled by the anti-communist Whites. The Imperial Russian Air Service became ashes, out of which emerged the Air Fleet of the Workers' and Peasants' Red Army.

George M. Mellinger

See also

Kozakov, Aleksandr; Seversky Aircraft; Seversky, Alexander P. de

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Independent Bombing Force (World War I)

Ostensibly interallied strategic bombing force formed during World War I. Insofar as legal niceties can be preserved during war, the Allies had always been careful to announce that bombing that might hit enemy towns was being done in specific retaliation for some attack already mounted by the Germans. This position kept faith with international treaties entered into prior to the war that prohibited the bombing of cities except in reprisal to a specific attack.

In late 1917, therefore, when the formation of a long-range bombing force came under discussion, this qualification still had to be observed, although there was also concern that the Germans should not be the only civilian population to escape being attacked. The governments, therefore, kept open the possibility of bombing military objectives no matter where they might be located.

In October 1917, Major General Hugh Trenchard, field commander of the Royal Flying Corps, was notified that he would head an Inter-Allied Independent Air Force that would be under the supreme command of French Marshal Ferdinand Foch. This chain of command was thought necessary because should Allied armies break through and press into Germany, aerial units under Trenchard would have to move there as well to stay within range of targets.

As it happened, however, there was no interallied presence in the force that was fielded; only British units were present. In the early months of 1918, the 41st Wing, and then units simply designated as Independent Force, RAF, operated out of Luxeuil, the same airfield near Nancy that No. 3 Wing had operated from in 1916.

Those squadrons utilized de Havilland D.H. 9s/9as and Handley Page O/400 bombers to perform missions against targets in Germany. At least, that is what was intended. In fact, weather and the still-deficient navigation technology combined to scuttle more missions than were completed. Missions begun in anticipation of hitting strategic targets, such as factories in German towns, typically were diverted to tactical targets (generally railroads or airfields) just behind the lines.

World War I came to an end before the technological issues preventing true strategic bombing could be solved. By 1939, that technology was in place and the missions that had to be abandoned in 1918 could be fulfilled.

James Streckfuss

See also

Royal Flying Corps/Royal Naval Air Service/Royal Air Force; World War I Aviation

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Indian and Pakistani Airpower

India and Pakistan, the two major powers in South Asia, have been locked in mutual hostility ever since the partition of the Indian subcontinent in August 1947. The trauma of partition led to human carnage, bloodshed, and violence on both sides. Further, Pakistan's forcible occupation of one-third of the Kashmir Valley in the 1947–1948 war with India turned into a root cause of their perpetual animosity. Since then, the countries have fought three wars: in September 1965, December 1971, and May 2000 (the Kargil conflict).

The perceptions of mutual threat prompted Islamabad and New Delhi not only to raise their armed forces but also to increase and upgrade airpower as an integral part of military strategy to ensure maximum security and safeguard territorial integrity and sovereignty.

At the time of partition, the nations inherited a split air force that was weak in quantitative and qualitative terms. The assets of the Royal Indian Air Force were divided on a one-third basis, under which Pakistan and India got two and six fighter squadrons, respectively. In view of India's military advantage, Pakistan's leaders heavily banked upon airpower while structuring the Pakistani air force on a tactical-cum-offensive strategy to counter any Indian threat to its security. Its air force got a potential boost from the United States when Pakistan joined U.S.-sponsored military alliances (SEATO in 1954 and CENTO in 1955).

As a result, Pakistan acquired F-104A Starfighters, B-57B Canberras, the highly sophisticated F-16 fighter, and AWACS from the United States. Pakistan received additional support from France (Mirage-series fighters), China (MiG-21, F-6, F-7P), Australia (Mirage III), and Muslim countries of the Middle East.

India looked to the former Soviet Union for military hardware to meet its defense requirements. India acquired MiG-21 fighters from Moscow and Mirage 2000s from Paris in the 1970s and 1980s, in addition to Jaguars from the United Kingdom. The Indian air force added 44 MiG-27 fighters to its inventory during 1992–1993.

In view of these developments, the Pakistani government gave an advance of $600 million to the United States to purchase an additional 40 F-16 aircraft, but they were not delivered when the first Bush administration placed an arms embargo on Pakistan in October 1990 under the Pressler Amendment (1985), which prohibited U.S. military and economic assistance to any country that was engaged in building nuclear weapons. The Clinton administration amended the Pressler Amendment in January 1996, as a one-time waiver that enabled Pakistan to get military assistance and spare parts worth $368 million.

After the May 1998 nuclear tests carried out by India and Pakistan, both countries increased their airpower and replaced old aircraft. India acquired two AWACS A-50s from Russia; no other country in the region possesses such aircraft. India had already acquired Su-30 and MiG-29 from Russia under the defense deal. During Russian President Vladimir Putin's visit to India in 2000, the countries signed defense agreements. Russia will deliver military hardware worth $3 billion including Su-30 fighters, the *Admiral Gorshkov* aircraft carrier, and two squadrons of MiG-29K fighters. Also, India will manufacture 140 Su-30MKI aircraft under license and will upgrade 50 Su-30 planes. India is trying to procure at least one airborne early warning system from Israel. The delivery of 10 Mirage 2000Hs from France at the cost of $328 million is expected to be completed by 2004. This will give India an air edge over Pakistan. India is planning to purchase 350 multirole planes and other gadgets at an estimated cost of $25 billion over 15–20 years.

In response, Pakistan is moving forward to field 150–200 S-7 multirole combat aircraft, replacing its old fleet of F-6s,

Indian and Pakistani Airpower

Aircraft Type	*Combat Radius*	*Inventory*	*Supplier*
India			
Su-30 MK	1200 km	30	Russia
Mirage 2000H/TH	750 km	35	France/U.K.
Jaguar S(I)	550 km	88	France/U.K.
Mig-27	250 km	147	Russia
Pakistan			
Mirage III EP	600 km	16	France
Mirage 5	650 km	52	France
F-16A/B	950 km	25	U.S.

SOURCE: Rodney Jones, Regional Studies (Spring 2000): 13.

A-5s, and F-7s. The S-7s will have look-down-shoot-down targeting, night-combat, and electronic-jamming capability. The S-7 is a multirole, multimission project commenced by Pakistan as far back as 1991. Pakistan is in the process of acquiring the latest F-7MG aircraft from China.

The defense budgets of India and Pakistan for fiscal year 2000/2001 show that India's defense outlay is more than four times greater (R587.87 billion) than that of Pakistan (R133.5 billion). But in terms of gross domestic product, India spends 3.2 percent on defense, whereas Pakistan spends more than 4 percent. The above table illustrates the comparative strength of the nuclear-capable high-performance strike aircraft of India and Pakistan until 1999.

India and Pakistan will continue modernizing their air forces as a counteroffensive strategy and will keep readying their fighter aircraft for the delivery of nuclear weapons, in addition to upgrading various missile systems.

B. M. Jain

Indochina

During the period 1945–1954, France fought to regain control over its possessions in Indochina: Cochinchina, Annam, Tonkin, Cambodia, and Laos. These were occupied by Japan during World War II and then witnessed the rise of an anticolonial movement led by local communists. France's postwar weakness significantly complicated its military efforts—including the use of airpower—in Indochina.

The air war in Indochina formally was one-sided. The only air forces employed were those of France and its allies. Yet local forces paid great attention to the abilities and limits of airpower in strategic planning and operational and tactical decisions. This enabled communist-led peasant guerrillas to challenge French air supremacy asymmetrically and contributed to their victory. Additionally, the French air experience in Indochina emphasized the importance of the principle of economy and distribution of forces and the crucial need to suppress enemy air defenses during ground support operations.

The aerial conflict in Indochina also had a formidable international dimension: Japan, Britain, China, as well as the Soviet Union and the United States were involved, though in different forms and on different stages during the conflict.

In the fall of 1945, British and French forces were airlifted to French Indochina to establish order after the Japanese surrender. This brought the allies into conflict with the communist-led Vietminh movement, which declared the independence of Vietnam (Cochinchina, Annam, Tonkin).

In 1945–1946, the British provided combat air support and allowed some Japanese air transport units (the so-called Gremlin Task Force) for the advancing French troops in Cochinchina, Annam, and Cambodia. During the 1946–1949 campaign in Tonkin and Laos, French airpower supplied ground support as well as delivering troops and cargo in jungle and mountainous terrain. The French expeditionary corps also used parachute-dropping to gain control over Luang Probang and Haiphong and employed combined air/airborne and ground assaults in two large-scale operations: PAPILLON (Hoah Binh, April 1947) and LEA (Viet Back, October 1947).

In April 1947, the French made the first aircraft-carrier strike in its military history. During the war French air forces and naval aviation (one or two French aircraft carriers were constantly off the Indochinese shores) developed close and effective interservice cooperation.

In Indochina the French had an extremely diverse aircraft inventory, including the Supermarine Spitfire IX, North American Mustang, Consolidated PBY-5 Catalina, Douglas C-47, as well as other allied types. There were also German Ju 52 transports and Japanese Nakajima Ki 43 fighters. This wide variety of types created serious maintenance and operational problems.

As continental China fell under communist control and the Korean War began, the international setting of the war in Indochina changed dramatically. The United States sent additional planes to the French. The Vietminh managed to transform its guerrilla bands into a disciplined and highly motivated regular army supplied from China and the Soviet Union.

In 1950–1952, both sides employed the mobile warfare operations. The French escalated airpower involvement in Indochina (more than 10 major air bases and 275 planes at its high) using aircraft in the combined air/airborne-ground operations. These were mostly successful in eliminating about a third of the Vietminh combat force.

The French air force contributed to the victorious campaign by bombing raids (the French used napalm for the first time in December 1950), supporting the airborne assaults (Operation LORRAINE, Na-San, December 1952), as well as providing supplies and transportation for troops (the Lang Son, Ninh Binh, and Hoah Binh battles).

In order to consolidate and explore the 1950–1952 military successes, the French command under General Jean de Lattre de Tassigny introduced some strategic, operational, and tactical innovations. It assembled forces (including air units) into combined mobile strike groups. To compensate for the shortage of bombing power, which the campaign revealed, the French began to use transports as bombers.

Additionally, the French command developed the concept of air-supported and air-supplied combat outposts and fortified supply centers for control over territory and antiguerrilla operations. Despite some initial successes in northern Laos, the idea of airmobile warfare in difficult climate and complex terrain seriously overestimated French capabilities in Indochina.

The Vietminh forces under General Vo Nguyen Giap understood the vital role of airpower in the new French strategy. They decided to challenge by shifting guerrilla operations deep inside Indochina—almost at the limit of the maximum range of most of the French planes flying from their bases in coastal areas and aircraft carriers. Additionally, the Vietminh used terrain to cover its movements, employed massive artillery assaults on enemy airfields, and concentrated antiaircraft fire.

French self-assurance and underestimation of the enemy met revolutionary tactics when the French, under new commander General Henri Navarre, tried to lure the enemy into a decisive battle inside Vietminh-controlled territory. This course, accompanied with growing logistical problems and air-support limits, led to the military disaster at Dien Bien Phu in 1954.

The French were on their own. With the surrender of the French garrison in Dien Bien Phu, the war was virtually over. France lost 59 aircraft (48 shot down, 11 destroyed on the ground), 167 planes damaged, 270 airmen killed, and 380 missing in action; 70 civilian crewmembers were killed as well.

The critical shortage of French strike airpower, which the conflict had revealed, led to the restoration of the separate bombing force within the French air force. The French also assisted in creating the South Vietnamese air force. The war experience had also proved the value of air defense for the communist forces and shaped the buildup of the North Vietnamese military. For China, the Soviet Union, and particularly the United States, the war paved the way for further involvement into conflicts in Indochina.

Peter Rainow

See also

Colonial Wars; Dien Bien Phu, Battle of; French Air Force; French Naval Air Force; Vo Nguyen Giap

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Inoue, Shigeyoshi (1889–1975)

Japanese admiral. Inoue graduated from the Naval Academy in 1909. After sea service and a two-year posting to Switzerland, he graduated from the Naval Staff College in 1924. More sea service, important staff billets, and two years as naval attaché in Rome followed before Inoue made rear admiral in 1935. In 1937, Inoue headed the Naval Affairs Department in the Ministry of the Navy and, after promotion to vice admiral in 1939, became the China Area Fleet Chief of Staff.

In 1940, Inoue headed up the Naval Aviation Bureau. He launched a major attack on the navy's shipbuilding program, particularly battleship construction, and strategic planning for a war with the United States. He posited a protracted war rather than the lightning conflict Japanese strategists envisaged and clearly appreciated Japan's weakness relative to America's industrial might and strategically advantageous position. He concluded that success required powerful long-range land-based air forces, numerous effective convoy escorts backed by strong integrated surface, air, and submarine task forces, and well-trained and -prepared amphibious assets. Even then, Japan would fight at long odds.

Inoue's radical views led to his transfer in August 1941 to command of Fourth Fleet. His forces captured Guam and Wake and then moved through the Southwest Pacific archipelagos to Rabaul. Inoue, however, lost his command after the Port Moresby operation failed in the Coral Sea; he became superintendent of the Naval Academy.

Late in the war Inoue regained favor. He was promoted admiral and became simultaneously navy vice minister and chief of both the Navy Technical Bureau and Naval Aviation Bureau.

Paul E. Fontenoy

See also
Coral Sea, Battle of the; Japanese Naval Air Force, Imperial; Netherlands East Indies; Philippines; Rabaul; Yamamoto, Isoroku

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INSTANT THUNDER (1990)

Code name for the initial Coalition plan and air campaign in response to the Iraqi invasion of Kuwait on 2 August 1990. A small group of airpower advocates in the Pentagon—the so-called Checkmate office—proposed a conventional strategic air campaign to liberate Kuwait. The group, which was under the direction of Colonel John Ashley Warden III, had one clear purpose in mind: force Iraq's army out of Kuwait by applying airpower in a strategic offensive directly against the sources of Iraqi national power. The concept was praised and condemned; although changes were made, the original concept remained at the heart of what became the strategic air campaign (Phase I) of Operation DESERT STORM.

INSTANT THUNDER, as presented to the U.S. military and political leadership between 9 and 20 August 1990, was bold, imaginative, and innovative but not in accord with then current military doctrine and what was operationally attainable and politically acceptable. The concept's stated objectives were to "isolate Saddam [Hussein]; eliminate Iraq's offensive and defensive capability; incapacitate the national leadership; reduce the threat to friendly nations; and minimize the damage to enhance rebuilding." INSTANT THUNDER provided the U.S. leadership with an offensive option that did not exist at the time, and it gave the overall planning a strategic orientation.

As intelligence and targeting information improved during planning, Brigadier General Buster Glosson and Lieutenant Colonel David A. Deptula developed the concept in accordance with theater requirements. On 17 January 1991, the target list had increased from 84 to 481, and as the war progressed several more targets were attacked. What was solely an airpower concept—focusing predominantly on the Iraqi decisionmaking apparatus in Baghdad—became a comprehensive air campaign, and the effectiveness of this part of the air campaign compared to the larger effort against Iraqi troops in the Kuwait theater of operations remains widely disputed. INSTANT THUNDER, with its focus on strategic bombing, remains a controversial issue within the wider airpower debate, as does its genesis and relationship to the final air campaign plan.

John Andreas Olsen

See also
Deptula, David A.; DESERT STORM; Warden, John A. III

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Iran Hostages Rescue Operation

Operation EAGLE CLAW, the failed special operation to rescue Americans taken hostage by militant Iranian students who seized the U.S. Embassy in Tehran. In January 1979, the followers of Ayatollah Ruhollah Khomeini, a conservative Muslim clergyman, forced Reza Shah Pahlavi, who had ruled Iran for 37 years, to flee abroad. On 4 November 1979, militant Iranians, who supported the Ayatollah and opposed Western influences, stormed the U.S. Embassy in Tehran, the capital of Iran, taking 66 Americans hostage. Thirteen were soon released, but for the release of the other 53 Iran demanded a U.S. apology for acts committed in support of the shah, his return to face trial (unimportant after his death in July 1980), and the return of billions of dollars that he was said to have hoarded abroad.

Negotiations did not secure their release, so President Jimmy Carter ordered the Department of Defense to draw up plans for a rescue mission. The plan called for a joint task force using helicopters to insert commandos to assault the embassy and extract the hostages. The operation, launched on the evening of 24 April 1980, was plagued by problems from the beginning. It was ultimately aborted with the force at the intermediate staging area in Iran, called Desert One, because mechanical failures left the force without enough helicopters to complete the mission. The operation turned into a disaster when one of the helicopters sliced into a C-130 on the ground, causing a tremendous explosion. Eight Americans were lost in the debacle. The hostages were not released until January 1981, 444 days after they entered captivity.

The most important result of the raid's failure was a reassessment of America's Special Operations Forces (SOF), which ultimately led to the creation of the United States Special Operations Command, a unified joint headquarters with responsibility for all SOF. The ad hoc arrangements faced by the planners and executors of Operation EAGLE CLAW would no longer be necessary.

James H. Willbanks

See also

Helicopters, Military Use; Lockheed Martin C-130 "Hercules"

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Iraqi Air Force

In the period of the Iran-Iraq War (1980–1988), the Iraqi Air Force (IQAF) emerged as the sixth-largest air force in the world. With some 30,000 active personnel and such aircraft as the MiG-29 Fulcrum, Su-24 Fencer, and Mirage F l, the IQAF was organized into two bomber squadrons, about 20 fighter ground attack squadrons, about 15 interceptor squadrons, and one reconnaissance squadron. Its formations were disposed in 24 major operating bases with more than 100 airfields and six times as many shelters.

With 10,000 men in the Air Defense Command, Iraq had a land-based air defense system that divided the country into five operational sectors providing a comprehensive cover through an integrated network of radars, antiaircraft guns, and some of the latest French and Soviet surface-to-air missiles. The Iraqi strategy during the 1991 Gulf War was to draw the Coalition into a costly battle of attrition. The strategy depended on high survivability and the effectiveness of Iraq's land-based air defense network, but the Coalition's offensive neutralized the Iraqi system within the first days.

The IQAF did not challenge the Coalition for air superiority, and when hardened aircraft shelters proved vulnerable 148 aircraft were sent to Iran for safety. In the course of the war, the IQAF lost more than half of its combat aircraft (the aircraft sent to Iran were not returned), half its major command, and control centers and large numbers of munitions and antiaircraft guns. The overall estimates of Iraqi losses are uncertain, but the IQAF still consists of some 30,000 men. The command and control system has been largely restored, and some 300 combat aircraft survived the bombing. Although the IQAF retains half its 1990 numbers, its warfighting capability is difficult to assess. It has the advantage of lessons learned, but economic sanctions have made acquisitions of spare parts and new equipment difficult, and the continuous operations in the no-fly zones have weakened training and readiness. At the moment, missiles seem to be the preferred solution; with biological and chemical weapons being prepared, the IQAF sustains a considerable domestic and regional air strike capability.

John Andreas Olsen

Israel Aircraft Industries (IAI)

After the 1948 War of Independence, Israel was determined to have an indigenous armament industry, and an aircraft factory was considered essential. First established in 1953 as Bedek Aviation, the firm changed its name to Israel Aircraft Industries in 1967. Over the years, the firm has produced domestic as well as foreign designs. It excels in modifying designs from other countries for manufacture in Israel.

One of the first indigenous designs was the twin-boom IAI Arava, a twin-engine turboprop transport capable of carrying up to 18 passengers. Of the 90 built, many were sold abroad.

IAI established itself as a leader in the executive aircraft market when it acquired the manufacturing rights for the North American Rockwell Jet Commander, manufacturing and selling it as the Westwind. The Westwind was succeeded by the Astra, a much more advanced aircraft featuring a swept wing.

In the military field, IAI developed the Kfir, based on the Mirage III airframe modified to use a General Electric J79 turbojet. A total of 212 Kfirs were built and served as a first-line fighter for the Israeli Defense Force. A much more ambitious project was the Lavi, an indigenous design that promised great performance but was canceled because of high costs.

Walter J. Boyne

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Israeli Air Force

Few military organizations have the mystique of the Israeli Air Force (IAF). What began in 1947 as a literal hodgepodge of mercenary pilots flying war-surplus fighters, bombers, and transports had by 1967 become synonymous with air

Israel has done a magnificent job of adapting foreign warplanes to its needs, and never more so than with the IAI Kfir, a highly modified version of the Dassault Mirage 5. (Lon Nordeen)

supremacy. The predecessor to the IAF—the Shen Aleph (Air Service)—was established in November 1947, although flying clubs known as Sherut Avir date from the early 1930s. The air service was reorganized into the Heyl Ha'Avir in May 1948, concurrent with the founding of the state of Israel. It operated whatever airplanes it could buy, ranging from Czech Avia S-199s to Dragon Rapides to B-17s. Pilots were typically from the British Commonwealth, notably Canada and South Africa, or Sabras who had flown previously with the RAF. Among the latter is Ezer Weizman, famous for his all-black Spitfire, who eventually commanded the IAF.

By the mid-1950s, Israel had established a strong relationship with France and bought jet aircraft such as the Ouragan and Mystère to combat Egyptian and Syrian MiG-15s and MiG-17s. Israel was all too willing, therefore, in October 1956 to join with France and Britain in attacking Egypt. The IAF conducted paradrops at key passes in the Sinai, facilitating a rapid Israeli ground advance. By 1967, the IAF faced an imminent Arab assault and undertook one the most decisive operations in the history of air supremacy, destroying most of the Arab air forces on the ground in a preemptive attack.

This fractured the Franco-Israeli weapons link, and the IAF turned to the United States for replacement aircraft. By 1970, these included F-4Es, which were pressed into service during the War of Attrition through late 1973.

The October War demonstrated crucial weaknesses in the IAF, most notably its shortcomings in electronic countermeasures and defense suppression. These were remedied with follow-on purchases of the F-15 and F-16, with the F-16s including locally configured "Wild Weasel" variants. Israel also built a derivative of the Mirage III (the Kfir). These all saw service in 1982's "Peace for Galilee" operations over Lebanon and Syria, where Israeli fighters destroyed some 80 MiGs with no losses. Since then, the IAF has focused on indigenous high-technology weaponry such as the canceled Lavi fighter and the Israeli AWACS, which has even seen export sales. Undoubtedly, the key to success for the IAF has been its ability to achieve air supremacy, its effect on the morale of Israelis and their opponents, and its ability to supply and manage the battlefield.

Robert S. Hopkins

See also

Air Superiority; Egyptian Air Force; Israel Aircraft Industries; Israeli-Arab Conflicts; Osirak Nuclear Reactor; Six Day War; Suez Crisis; Syrian Air Force; Yom Kippur War

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Israeli-Arab Conflicts

Since the formation of the state of Israel, five major conflicts have occurred in the region (1948–1949, 1956, 1967, 1973–1974, and 1982) between various Arab states and Israel. Each conflict resulted in an Israeli victory due to superior airpower.

After declaring independence in 1948, Israel fought against forces from Egypt, Syria, Transjordan (later Jordan), Lebanon, and Iraq. Prior to the conflict, the Israelis purchased 25 Czechoslovakian Avia S.199 aircraft. The Israeli Air Force (IAF) received four of the planes by May 29. On that day, Israel's first fighter squadron attacked Egyptian forces en route to Tel Aviv, halting their advance at Ad-Halom.

For the duration of the war the IAF fought on all fronts, frustrating Arab attempts to divide the country in half and inflicting numerous kills against Egyptian Dakota aircraft. Mechanical failures with the Avia led the IAF to purchase four North American P-51D Mustangs from the United States. Shipped to Israel in crates labeled as agricultural implements to circumvent the embargo on military equipment to the Middle East, two of the aircraft participated in the last five months of the War of Independence, conducting reconnaissance and strike fighter/interceptor missions. On the last day of fighting, the Mustangs, armed with six 12.7mm machine guns and six 127mm rockets under the wings, shot down three Egyptian Macchi MC-205s.

At the conclusion of hostilities, the Mustangs continued to operate as the front-line force but were gradually phased out in favor of jets. However, when the 1956 Suez Crisis broke out the IAF removed the planes from storage and, with range capabilities reaching 2,080 miles and a maximum speed of 427 mph, used them to bomb enemy bases as far away as North Africa. In an effort to disrupt Egyptian military communications, the IAF attached a weighted cable to the tail of the Mustangs designed to cut telephone lines; several planes lost their cables before arriving in Egypt, but the pilots improvised by cutting lines with their wings. After the United Nations sponsored a truce between Great Britain, France, Israel, and Egypt, the IAF retired its remaining Mustangs.

In 1967, Egyptian forces attacked Israel in the Six Day War. The IAF responded in a coordinated air-land attack that resulted in a quick and decisive victory. The IAF relied on the French Mirage III, with a special version—the Mirage 5—being developed for the IAF. During the war the French government placed an embargo on military sales to the Middle East; following the Israeli raid on the Beirut airport in 1968, the administration canceled Israel's order for 50 Mirage 5s.

Through private acquisition and espionage, the Israelis obtained blueprints and proceeded to construct its own version. In January 1968, U.S. President Lyndon Johnson agreed to sell Phantoms to the IAF (44 F-4Es and six RF-4Es). These aircraft, used during the War of Attrition between Egypt and Israel after the Six Day War, illustrated Israel's air superiority, routinely flying over Cairo. Other operational aircraft during this period included three Dassault models (Ouragans, Mystères, and Super-Mystères) and Vautours from Sud-Ouest. Deployed as the primary defense against Russian-made SAMs, the Phantoms destroyed Egypt's missile sites.

Egypt responded by negotiating the purchase of 80 MiG-21 fighters from the Soviet Union. On 30 July 1970, Israeli Phantoms destroyed five Russian-operated MiG-21s, an act that resulted in an armistice on 7 August 1970.

The Yom Kippur War began at noon on 6 October 1973. Egyptian and Syrian forces attacked Israeli forces on the Suez Canal to the south and the Golan Heights to the north. Responding to attacks on Israeli population centers, the IAF attempted to destroy SAM sites along the Golan Heights, but when that strategy failed the IAF deployed two squadrons of 16 F-4 Phantoms across the Syrian border to destroy the enemy's command center. Flying low to avoid detection and maintaining radio silence, the F-4s reached Damascus undetected, releasing five tons of ammunition each before returning to Israel. The element of surprise worked to their advantage, with Syrian defenses destroying only one IAF plane. For the duration of the war the IAF also operated an Israeli-manufactured aircraft, the Nesher.

In 1978, the Palestine Liberation Organization initiated attacks against Israel from bases in Lebanon. After several years of continued fighting, the IAF attacked Beirut in 1982, forcing Palestinian guerrillas to evacuate the city after a 10-week siege. The Palestinians dispersed throughout the Arab world. Israel continues to maintain a buffer zone between Lebanon and its own territory. The IAF currently responds to all threats against the state of Israel by terrorists and foreign countries.

Cynthia Clark Northrup

See also

Israel Aircraft Industries; Osirak Nuclear Reactor; Six Day War; Suez Crisis; Yom Kippur War

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Italian Air Force (Post–World War II)

In June 1946, a referendum transformed Italy from monarchy to republic. In consequence, the Regia Aeronautica adopted the new name Aeronautica Militare (the Italian Air Force, or ItAF). Together, the limitations imposed by the 1947 peace treaty and the wartime devastations gave reason to doubt the very survival of the ItAF, but the Cold War allowed it to be rebuilt and then expanded as a mainly tactical force.

Initially, the use of surplus British and U.S. aircraft led to accidents caused by aircraft condition as well as different standards. Although still organized under the prewar territorial concept, with combat units assigned to four Air Zones (later three Air Regions), NATO membership introduced the ItAF to modern tactics and doctrine. The jet era arrived in 1950 with the de Havilland Vampire, so simple that its engine was the only real innovation, but British influence was soon ousted by the Mutual Defence Assistance Program. The abundance of U.S. aircraft, mainly various models of F-84 fighter-bombers and F-86E fighters, allowed considerable expansion and improved technology levels. A surface-to-air missile unit was formed in 1959 and deployed in the northeast. A brigade armed with Jupiter missiles and U.S. nuclear warheads in the south was disbanded in the aftermath of the Cuban Missile Crisis.

The key event of the 1960s was the selection of the Lockheed F-104 Starfighter, which would shape units and policies for more than 40 years. From 1982, strike units received the sophisticated Tornado, which in 1991 would equip the Italian contingent in the Gulf War. Although modest in numbers (eight aircraft, 226 sorties, 257 tons of bombs), this was the first ItAF combat campaign after World War II. The experience underlined the need for tankers, precision-guided munitions, and command and control assets.

The 1990s were marked by growing instability in the Balkans, which turned Italy into a massive logistics base for NATO forces; in addition, the ItAF participated in RED FLAG exercises and was employed in Somalia. In 1999, the ItAF introduced a new functional organization that placed all operational assets under the Air Fleet, supported by a Logistics Command and a Training Command. The ItAF served in combat against Serb targets.

Women were admitted to the ItAF in 2000. Future plans revolve around the Eurofighter and Joint Strike Fighter, increasing airlift capability, and reducing personnel to 44,000.

Gregory Alegi

See also

ALLIED FORCE; Cuban Missile Crisis; Eurofighter Typhoon; Gulf War; Joint Strike Fighter; Lockheed F-104 Starfighter; North Atlantic Treaty Organization; Panavia Tornado; Somalia

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Italian Aircraft Development

In 1913, Italy's Army Aviation Battalion launched a competition to select a two-seat general-purpose airplane. Although the entrants failed to meet the stringent requirements, the event achieved its goal of stimulating aircraft manufacture in Italy. Licenses, mainly French, put production on a firm basis but limited innovation.

Gianni Caproni took a different path, selling his fledgling company to the army but continuing to serve as technical director. Army funding allowed the construction of a number of prototypes, including the Ca.3 bomber (1914), which was the first important original Italian design. Its success owed much to the use of proven structural elements; more important, it made possible the aerial bombardment strategy advocated by Giulio Douhet. Like the U.S. DH-4 Liberty Plane program, the plan for 4,000 Ca.5s was crippled by its misunderstood magnitude, and the bomber was undeservedly tainted by the resulting postwar controversy.

The dependency on foreign technology continued throughout World War I, with successive adaptations of the Farman pusher by SIA and of the Aviatik B.I by SAML and Pomilio. Despite the failure of the Ansaldo attempt to break the Nieuport-Macchi fighter monopoly, its SVA was a milestone in Italian aeronautical design and pioneered scientific airframe stressing and wind-tunnel testing. Production considerations were incorporated at an early phase, minimizing the use of high-grade steel and other scarce materials.

Nieuport-Macchi rapidly established itself in the flying boat field, but other Italian aircraft were disappointing. Italy also operated the largest airship fleet after Germany. Douhet recognized airships as costly and cumbersome in 1914, but despite heavy combat losses they were eliminated in only 1928; their chief proponent, Umberto Nobile (1885–1978), eventually accepted an offer to head the Soviet dirigible program.

By November 1918, a significant design capability had been developed, and several important prototypes were on hand; the industry had swollen from 17 to 355 companies, including 27 airframe manufacturers, with more than 12,000 aircraft delivered and at least as many on order. On the minus side, the many failures and production delays had imbued the military with mistrust toward domestic designs. The early post–World War I period was dominated by war-surplus aircraft and engines, depressing innovation. Piaggio and Ansaldo introduced all-metal construction with Dornier and Dewoitine licenses; Romeo acquired steel-tube technology from Fokker, whereas Fiat developed its own. Engines came from France and Britain, with Fiat again representing a significant exception.

To protect industrial resources during the economic slump, three-year planning was introduced in 1930. Prices were determined on a cost-plus basis and orders allotted among companies in fixed proportions, with each type ordered from at least two manufacturers for standardization. Due to funding limitations, types were frequently upgraded and replaced only for measurable progress. Companies were asked to specialize by aircraft categories (e.g., fighters for Fiat and bombers for Caproni). Research was stimulated through design competitions: between 1926 an 1933, the Regia Aeronautica purchased some 160 prototype or experimental aircraft, including those used to establish world records for distance and endurance (SIAI Marchetti S.64, 1928–1931) and speed (Macchi seaplanes for the Schneider Cup, 1926–1931, and the 1934 absolute record).

Although the fascist policy of self-sufficiency restricted imports, Italo Balbo limited its impact on aviation and ensured the acquisition of U.S. technology, including Packard diesel engines and the Travel Air R racer. The Atlantic formation flights gave great impulse to instrumentation, both through licenses (Sperry gyros, Siemens direction finders) and domestic developments (OMI-Biseo blind-flying panel). By 1934, retractable landing gear, flaps, slats, and cantilevered monoplane wings had all been introduced. The SIAI Marchetti S.79 trimotor (1934) and Nardi FN.305 sportplane (1934) incorporated all simultaneously but mated them to traditional steel-tube fuselages and wooden wings that required skilled labor and high-quality wood; Fiat introduced the all-metal G.2 in 1932 but was plagued by unsophisticated aerodynamics and so added stressed-skin structures a decade later.

Throughout this period, Italian aircraft were comparable with those of other European nations; then, the wars in Ethiopia and Spain blocked the path of evolution. Increased budgets went to operations, pilot training, airfield construction in Africa, and greater output of existing types. Combined with the plan to achieve a 3,000 combat aircraft strength by 1939, this consumed the additional resources without producing lasting improvements. Although other European nations rearmed, Italian industry failed to increase factory capacity and to generalize stressed-skin metal structure; similarly, small orders deterred investment in modern production systems. Reggiane, organized along U.S. lines, was a significant but isolated exception. Further records were established, but at the expense of quality. With the exception of the world altitude records set in 1934–1939 by the Caproni Ca.113/161bis family, most were in limited categories or for point-to-point flights. In addition, results often depended more on skilled crews than on generally applicable technology.

Perhaps realizing the looming threat of obsolescence, the ministry launched a massive modernization plan that increased design competitions from the previous average of 2–3 per year to 15 in 1938–1939 yet failed to produce a single type employed operationally in World War II. Indeed, the major Italian combat aircraft were the result of previous competitions (e.g., the Macchi C.200, developed in response to the 1936 interceptor competition), private initiative (Cant Z.1007, Fiat CR.42), or adaptation (S.79).

The inability to produce acceptable engines over 1,000 horsepower was the main cause of this failure, but contributing factors included unrealistic performance goals, duplication of effort, small numbers of graduate engineers and scientists, low investment, and political interference (often at the request of industry, which exploited the regime's full-employment policy). In late 1939, Alfa Romeo acquired the license to the Daimler Benz DB.601 engine, but production began in 1941, and monthly deliveries never exceeded 60; the situation was repeated in 1943 with the Fiat-built DB.605. The failure of the 1,350-hp Alfa Romeo 135 radial doomed a generation of twin-engine designs and explains the Italian predilection for trimotors.

In turn, the lack of adequate engines generated the illusion that better performance would be achieved through innovative airframe design, providing yet more stimulus for new competitions and interference in development. Nowhere was this more evident than with the Fiat G.55 fighter. Launched as a "superfighter" in 1939, it was still not operational in summer 1943 despite orders for 3,600; the "lightweight fighter" propounded by SAI Ambrosini shared the same fate, mainly because no aerodynamic miracle could overcome the limitations of a 750-hp engine. A more realistic approach of continuous improvement, strictly linked to necessary power increases, allowed Macchi to develop its fighter family with minimal disruption to production and adequate performance. Despite this, Macchi types never exceeded 46.6 percent of fighter orders, and in the first half of 1943 Fiat still claimed 40.7 percent of fighter orders against Macchi's 34.7 percent.

When the war showed equipment to be as important as airframe and engines, Italy was handicapped by a lack of modern radios and heavy guns. In addition, manufacturers tended to produce their own accessories (in the case of Fiat, down to ball bearings), with little specialization and progress. Even when the Regia Aeronautica standardized Piaggio propellers for its fighters, Fiat fought to use its own. German requests for industrial coordination foundered because of a widespread fear of subjugation. The workforce rose to 160,000 by 1943, efficiency remained low, and the modest prewar monthly production target of 350 aircraft was never achieved.

Production plans for 1944–1945 revolved around large-scale production of the Fiat G.55 fighter, multiple variants of the Cant Z.1018/Breda Z.303 family, and limited quantities of Macchi and Reggiane types. All were scuttled by the September 1943 armistice, finally bringing Italian industry under German control. A few existing programs were allowed to continue, but efforts were concentrated on repairs, subassemblies, and tooling for German industry. Together with Allied air attacks in March-April 1944, this conspired to keep Italian wartime production at 11,000 aircraft.

Italy emerged from World War II without an aviation industry. Employment shrank to about 6,000 and was largely occupied with nonaeronautical work. Survival depended on overhauls and political connections. The engine business never recovered its modest design capability, and U.S. surplus aircraft limited the prospects for larger aircraft, forcing important companies like Breda, Caproni, and Cant out of the market.

Design activity resumed with light aircraft. Although established companies received military orders for piston trainers, Piaggio correctly viewed the United States as the largest aviation market but achieved only limited sales there. New designers like Stelio Frati (b. 1919) and Luigi Pascale (b. 1923) made their debut. Their most successful designs were the SIAI Marchetti SF.260 (1964) and Partenavia P.68 (1970), still in production together with the F.22 (1989) and P.92 (1993). Meteor, founded by Furio Lauri (b. 1918), went from light planes to remotely piloted vehicles before being acquired by Aeritalia.

Although the air force funded a limited experimental program, including the Aerfer family of light interceptors, the abundant supply of Military Direct Assistance Program aircraft made domestic production of aircraft pointless. The first postwar Italian combat aircraft to enter production was the Fiat G.91 light tactical fighter (1956), designed to a NATO specification drawing heavily upon F-86 experience. Other companies sought success abroad. Piaggio sold its P.149 to Germany, but the real surprises came from the Agusta-Bell helicopters and the Aermacchi MB.326/339 jet trainers.

The F-104G program involved virtually the entire Italian aviation industry, raising its technology levels, production capabilities, and ambitions. A decade later the Tornado was another milestone, but national programs told a different story. Like the industry, research funding was fragmented, and government viewed the sector as an opportunity to create jobs rather than technology. As a result, new products were developed very slowly (the Fiat G.222 was conceived in 1962, flew in 1970, and reached units in 1978; the Agusta A-109 was conceived in 1969, flew in 1971, and was delivered to the army in 1978); frequently, industry launched derivative designs at the expense of sales potential, as with the SF.260 turboprop versions. Other aircraft, like the G.222, were hampered by their high cost.

The so-called 1977 aviation bill funded the CBR-80, a fighter-bomber/reconnaissance successor to the G.91, which eventually became the AMX (1984). The most ambitious Italian aircraft ever built, the AMX was also the most controversial. It suffered from cost overruns (in part caused by production cutbacks) and technical troubles but was successfully used in the Balkans in 1997–1999. A similar fate befell the Agusta A-129 antitank helicopter, handicapped by the philosophy of lightness and unable to achieve export sales despite the good performance demonstrated in Somalia, including shipboard operations.

Weakened by the lack of commercial success and the collapse of military markets that followed the end of the Cold War, industry attempted to revamp older products and accelerated its strategy of partnerships and participation in advanced international programs like the Eurofighter Typhoon. Agusta launched three new helicopters, including the BA609 tilt-rotor with Bell, but by 2001 the Aermacchi M-346 lead-in fighter, based upon the experience of the Russian-Italian Yak-130 program, was the only significant new fixed-wing project under way with Italian leadership.

Gregory Alegi

See also

Aeritalia; Aeronautica Nazionale Repubblicana; Agusta; Alenia; Ansaldo; Balbo, Italo; Breda; Cant Aircraft; Caproni Aircraft (Post–World War I); Ethiopian War; Eurofighter Typhoon; Fiat; Italian Air Force; Lockheed F-104 Starfighter; Macchi Aircraft; Panavia Tornado; Piaggio Aircraft; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II); SIAI Marchetti; Spanish Civil War

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Italian Campaign (1943–1945)

Support of the Allies' protracted land campaign in World War II to take the Italian Peninsula. After the fall of Sicily in August 1943, Allied forces invaded mainland Italy in September at Salerno (Operation AVALANCHE) near Naples, Taranto (SLAPSTICK), and across the Straits of Messina in the toe (BAYTOWN). The heaviest air resistance was at Salerno.

Coincident with the landing at Salerno was the surrender of Italy to the Allies. When the Italian fleet attempted to escape from its northern base at La Spezia to Malta, German Dornier Do 217 aircraft based in southern France attacked and sank the battleship *Roma* with newly developed Fritz-X glider bombs, a true guided missile.

After defeating German forces at Salerno, the U.S. Fifth Army and Eighth Army linked up and overran most of southern Italy, including the Foggia complex, which became an important base for the strategic bombers of the Allied Fifteenth Air Force.

German forces stopped the Allies along the Gustav Line, which stretched across Italy through mountainous terrain north of Naples. The campaign through the winter consisted of repeated Allied attacks that made only small gains against this position, which included Monte Cassino.

Allied efforts to break the Gustav Line were finally successful in May 1944 with Operation DIADEM, an attack from the south that took Cassino and linked up with the Anzio beachhead. Rome fell on 5 June. DIADEM was assisted by Operation STRANGLE, a massive interdiction campaign against German communications and logistics. Strangle was succeeded in the fall by Operation MALLORY MAJOR, which continued operations against German communications in northern Italy. But with bad weather approaching, German forces rallied and held the Allies along the line of the northern Appenines.

After the loss of Rome, the Luftwaffe largely abandoned the air war in Italy, leaving only a few Ju 87s for night harassment and loyal Italian fighter aircraft for defense of industrial sites in northern Italy. The remainder of the campaign in Italy consisted of Allied ground support and interdiction missions against negligible opposition and strikes against remaining industrial targets in northern Italy.

Allied air forces in Italy also provided important support to Marshal Tito's partisans in the Balkans. Transport aircraft (C-47s and Italian Z.1007s and SM.82s flying for the Allies) provided essential supplies to Tito, and direct attacks against German forces stopped an antipartisan operation in May 1944. Allied airpower based in Italy eventually severely degraded Axis rail capability in the Balkans.

Frank E. Watson

See also

Anzio; Cassino, Battle of; HUSKY; STRANGLE

Salerno; References

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Italo-Turkish War (1911–1912)

First use of heavier-than-air aircraft in combat. In September 1911, Italy committed an expedition against the Turks in Libya. After Tripoli fell in October, aircraft were unloaded in the port and prepared for use. On 23 October, Captain Carlos Piazza flew the first operational combat sortie in a heavier-than-air aircraft, completing a reconnaissance mission outside of Tripoli in a Blériot 11. Three days later, Captain Ricardo Moizo's Nieuport became the first aircraft to sustain combat damage when it was hit by Turkish rifle fire.

On 1 November, a Lieutenant Govotti, in an Etrich "Taube," became the first pilot to fly a bombing mission, dropping grenades on Turkish troops at Taguira Oasis. Other missions included the dropping of propaganda leaflets inciting insurrection among Libyan tribesmen, but reconnaissance and artillery spotting remained the primary missions. Other firsts in the campaign included the first night missions, night bombing, and the first operational air casualties from both ground fire and accidents.

The Italian feats in Libya were widely reported and had significant influence on the development of all fledgling air forces in the short months before World War I.

Frank E. Watson

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Iwamoto, Tetsuzo (1916–1955)

Imperial Japanese Navy lieutenant (junior grade). Iwamoto was born in 1916 in Hokkaido Prefecture. He attended Masuda Agricultural and Forestry High School. Iwamoto entered the naval barracks at Kure as a seaman in 1934. In 1935, Iwamoto was transferred to maintenance duty. In December 1936, he entered and graduated from the pilot training course and became a fighter pilot.

In early 1938, Iwamoto was assigned to the 12th Air Group, which took part in central China operations. Iwamoto's entry into combat was a very successful one. His first mission was to Nanchang, where he shot down five enemy aircraft. While in China, Iwamoto flew a total of 82 sorties, tallying 14 aircraft shot down and making him the top ace of the so-called China Incident.

During the early stages of World War II, Iwamoto served on the carrier *Zuikaku.* While onboard, Iwamoto participated in the Pearl Harbor attack, Indian Ocean operations, and the Battle of the Coral Sea. From there, Iwamoto's travels brought him to Paramushir Island, Rabaul, Truck Island, and finally back to Japan to participate in the defense of the homeland. Iwamoto's final victory tally is somewhere between 80 (Japanese historians' total) and 202 (Iwamoto's claim). Tetsuzo Iwamoto died in 1955 of complications from a war wound.

David A. Pluth

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Iwo Jima

Sustained air campaign during 1944–1945 to wrest the strategically important island of Iwo Jima away from Japanese control. By mid-1944, two Japanese airfields operated on Iwo Jima, with a third under construction. All served to stage aircraft and support attacks against the U.S. advance toward Japan's home islands.

From August 1944, U.S. forces subjected the island to one of the Pacific War's longest sustained aerial bombardments. Saipan-based Seventh Army Air Force B-24s launched 10 raids in August, 22 in September, and 16 in October. Airfields were their principal targets, but they also attacked shipping.

The B-24s ceased their attacks to support B-29 operations against Japan itself that commenced in November. The Japanese responded by raiding Saipan with aircraft staged through Iwo Jima, causing substantial B-29 ground losses. A major U.S. retaliatory attack followed on 8 December—62 B-29s and 102 B-24s dropped 814 tons of bombs on the airfields. Nevertheless, this attack and subsequent daily B-24 raids until 15 February 1945—bringing total bomb tonnage dropped on the island to 6,800 tons—did not close the airfields for more than a few hours or halt the flow of Japanese reinforcements.

In preparation for landings on Iwo Jima, fast U.S. carriers struck the Japanese mainland on 12–17 February, attacking manufacturing plants, aviation facilities, and shipping. They then joined 12 escort carriers of the support group in the preinvasion bombardment of the island.

After the 19 February landings the fast carriers and support group provided fighter defense, antisubmarine patrol, artillery observation, photoreconnaissance, and direct support strikes for the Marines in their bloody struggle to subdue the island. Japanese torpedo-bombers and kamikazes from Okinawa struck back at the invasion fleet, damaging several vessels. The fast carriers withdrew on 1 March to prepare for the Okinawa operation, but the escort carriers, aided by Saipan-based B-24s, continued their support of the Marines until the island was officially secured on 16 March.

Paul E. Fontenoy

See also
Japan, Air Operations Against; Kamikaze Attacks; Mitscher, Marc Andrew; Okinawa; Spruance, Raymond A.; Task Force 38/58

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J

Jabara, James (1923–1966)

USAF colonel; the world's first jet ace, and the second-highest scoring U.S. ace of the Korean War with 15 victories. Holder of the Distinguished Service Cross, Distinguished Flying Cross (six Oak Leaf clusters), Silver Star with Oak Leaf cluster, Air Medal (24 Oak Leaf clusters), and the British Distinguished Flying Cross.

James Jabara was born on 10 October 1923 in Oklahoma but raised in Wichita, Kansas. The son of hard-working Lebanese immigrants, he rose in the Boy Scouts to the rank of Eagle Scout while still working in his family's grocery store. Graduating in 1943 from the Army Air Corp's officer flight school, he flew more than 100 missions in the P-51 Mustang with the Ninth Air Force's 363d Fighter Group. In 1944, the wiry Jabara earned his first Distinguished Flying Cross with 1.5 German kills.

Jabara, flying the F-86A Sabre Jet with the 334th Fighter Inceptor Squadron of the 4th Fighter Interceptor Wing, began operating in Korea in December 1950. He got his first kill on 3 April 1951 over MiG Alley and the Yalu River. By the end of that month he was the leading U.S. scorer with four kills. The 334th was rotated to Japan, but it was decided to keep Jabara in Korea to make ace.

On 20 May 1951, during his sixty-third of an eventual 163 missions, Captain James Jabara became the world's first jet-versus-jet ace. Over Sinuiju, 28 Sabre Jets were jumped by 50 MiGs. After a failed attempt to drop one of his auxiliary fuel tanks, he was still able to down two MiGs with gun kills. He was awarded another Distinguished Service Cross and ordered back to the States on a publicity tour.

Jabara volunteered to go back to Korea in early 1953. Between late May and mid-July, he quickly became a triple-ace. By 15 July 1953, he had shot down his fifteenth MiG. He ended the Korean War as the second-leading U.S. ace.

Rising quickly through the ranks of the Air Force, Jabara had all the qualities of the stereotypical U.S. fighter-pilot ace. He was disciplined, heroic, patriotic, a hard-drinking smoker, a dedicated family man, and an exceptional aviator. In 1966, while delivering a plane to Vietnam, he was able to fly a combat mission and get assigned to a 100-mission tour of duty.

James Jabara shot down five-and-a-half aircraft in World War II and destroyed four more on the ground. In Korea, flying F-86s, he became the first American jet ace and went on to become the second-ranking American ace in Korea, with fifteen victories. (U.S. Air Force)

The first African-American four-star general, Daniel "Chappie" James, in a characteristic pose before his Phantom. (U.S. Air Force)

On 17 November 1966, at the age of 43, James Jabara was killed in an automobile accident near Delray Beach, Florida.

Scott R. DiMarco

See also

North American F-86 Sabre; North American P-51 Mustang

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James, Daniel "Chappie" (1920–1978)

First African American U.S. Air Force four-star general. Daniel James was born in Pensacola, Florida, the youngest of 17 children, and was nicknamed Chappie for an older brother. James grew up watching Navy planes. He did not join the Navy, though, because he did not want to be a cook (the armed services at this time were still segregated, and opportunities for blacks were few). In 1939, when a federal law authorized civilian pilot training at universities, he was a student at the Tuskegee Institute. In his senior year James enrolled in the Civilian Pilot Training Program run by the Civil Aeronautic Authority.

His basic flight training was in a Piper Cub, then Stearman PT-17s and PT-19s at Moton Field, home of the 99th Pursuit Squadron, the famous Tuskegee Airmen, commanded by Benjamin O. Davis Jr. Although stationed at Selfridge, Michigan, and Freeman, Indiana, during racial disturbances, James was not involved. In January 1946, he moved to Lockbourne, Ohio, still a segregated base.

After desegregation of the armed services, in 1949 James went to Clark Air Base in the Philippines. During the Korean War, he flew 100 missions in P-51s and F-80s. In 1950, Captain James returned to Clark, then moved to Griffiss Air Force Base, New York, and flew F-86s. Next he went to Otis Air Force Base, Massachusetts, where he became the first African American commander of an integrated fighter squadron in the continental United States.

By 1960, he was a lieutenant colonel at RAF Bentwaters. During the turbulent 1960s, his lack of activism and favoritism to blacks, as well as camaradarie with whites, made him the object of ridicule from radicals. During a tour of Vietnam, he flew under Robin Olds, participating in the famous Operation BOLO.

At Wheelus, Libya, in 1968 he faced down Muammar Qaddafi at the main gate, hand on revolver. He got his first star in 1970 and in 1975 became the first black four-star general. James overcame his youthful reputation as a brawler to serve as a speaker for the Pentagon on patriotism, loyalty, and commitment to the POW/MIA effort. In 1977, he had a heart attack; he retired in 1978 and died shortly thereafter.

John Barnhill

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Japan, Air Operations Against (1942–1945)

Despite widespread awareness about the vulnerability of the Japanese home islands to air attack—reinforced by the results of the Doolittle Raid on Tokyo on 18 April 1942—U.S. plans for an air war against Japan remained vague until well into 1943 because of American limitations in resources and technology.

The development of the Boeing B-29 Superfortress changed this situation. Eventually, more than 1,000 of the long-range aircraft were deployed in the Twentieth Air Force under the direct control of the Army Air Forces commander, General Henry "Hap" Arnold, subdivided into the XX and XXI Bomber Commands. Under pressure to get results from his expensive very-heavy bomber program, he fielded the new aircraft even before testing had been completed.

In June 1944, B-29s from Major General Kenneth Wolfe's XX Bomber Command began bombing Japan from China as part of Operation MATTERHORN. The campaign was plagued by logistical problems that got worse when Japanese troops overran advanced Allied airfields in China. Arnold replaced Wolfe with the USAAF's premier problem-solver, Major General Curtis LeMay. However, even he could not make MATTERHORN a success.

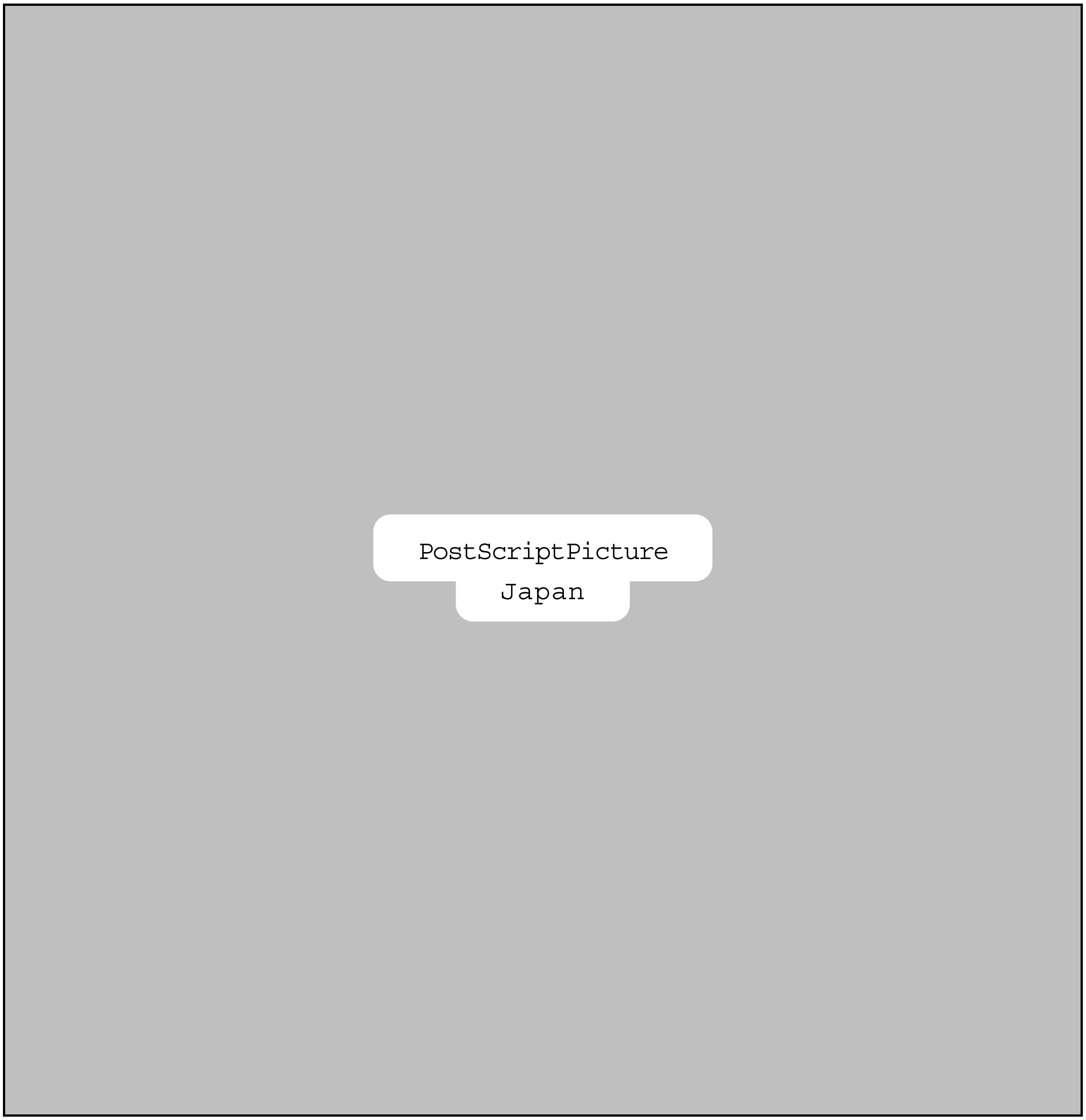
Arnold's greatest hopes for an airpower victory over Japan rested with Brigadier General Haywood "Possum" Hansell's XXI Bomber Command, which began operations from the Mariana Islands in November 1944. Hansell was one of the architects of the precision-bombing doctrine, but his operations also had little success. Poor facilities, faulty training, engine failures, cloud cover, and jet streams at bombing altitudes made precision methods impossible. Hansell seemed unwilling to change his tactics, however, and Arnold feared that he would lose control of the heavy bombers to Allied Pacific theater commanders without better results, so he consolidated both bomber commands in the Marianas under LeMay and relieved Hansell.

LeMay instituted new training and maintenance procedures but still failed to achieve useful results with daylight high-altitude precision attacks. He decided to resort to low-level incendiary raids at night. Although area-firebombing went against dominant Air Forces doctrine, flying at low altitude reduced engine strain, required less fuel, improved bombing concentration, avoided high winds, and took advantage of weaknesses in Japanese defenses. LeMay's systems analysts predicted that he could set large enough fires to leap firebreaks around important industrial objectives. His first application of the new tactics, Operation MEETINGHOUSE, against Tokyo on the night of 9 March 1945, produced spectacular destruction and was the deadliest air raid of the war.

Once enough incendiaries were stockpiled, the fire raids began in earnest. Warning leaflets were also dropped, which terrorized 8 million Japanese civilians into fleeing from cities. When General Carl Spaatz arrived in July to take command of U.S. Army Strategic Air Forces in the Pacific, including the Eighth Air Force redeploying from Europe, and to coordinate strategic air operations supporting the invasion of Japan, he had a directive to shift the air campaign from cities to transportation. But there was too much momentum behind the fire raids, sustained by operational tempo, training programs, and bomb stockage.

By the time Spaatz arrived, naval carrier strikes were also hitting key industrial objectives in Japan. More important, a submarine blockade had crippled the Japanese economy, the Russians were about to attack Manchuria, and Spaatz maintained direct command over the 509th Composite Group of B-29s specially modified to carry atomic bombs. Directed by Washington to deliver these weapons as soon as possible after 3 August, Spaatz ordered the attacks on Hiroshima and Nagasaki. These different elements combined with the incendiary campaign to comprise the series of blows that produced Japanese surrender.

As with the atomic bomb, there is still debate over the effects and morality of the firebombing raids. LeMay's bombers burned out 180 square miles of 67 cities, killed at least 300,000 people, and wounded more than 400,000. His 313th Bomb Wing also sowed 12,000 mines in ports and waterways, sinking almost 1 million tons of shipping in about four months. LeMay remained convinced that his conventional bombing could have achieved victory by itself. LeMay,



his tactics, and the legacy of the atomic bombs would be a primary influence in the shaping of the new United States Air Force.

Conrad C. Crane

See also

Atomic Bomb; Boeing B-29 Superfortress; Doolittle, James H.; Hiroshima; LeMay, Curtis E.; Nagasaki; Spaatz, Carl Andrew; Tokyo Air Raids

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Japanese Air Self-Defense Force (JASDF)

The air force component of the post–World War II military forces of Japan, established with the creation of the Japanese Self-Defense Forces (JSDF) in 1954. The founding of the JSDF ended the demilitarization that had been imposed on Japan by the United States and its Allies at the end of World War II. The emphasis on self-defense in the new military force structure was a reflection of the Japanese constitution and internal political attitudes toward the military, which outlawed offensive military capabilities and prevented operations outside Japan until a 1994 law allowed limited peacekeeping operations abroad. Additionally, U.S. deterrence forces and the presence of U.S. military units in Japan provided protection for the homeland.

The Japanese Air Self-Defense Force was molded by close links to the United States Air Force. The bulk of the combat aircraft were of U.S. design (F-86s, F-104s, F-4s, and F-15s), although they were often built by Japanese industry, which also produced Japanese-designed trainers and a ground attack variant. The bulk of the inventory has been interceptors, with a small attack force for support of the Ground Self-Defense Force (GSDF) and the Maritime Self-Defense Force (MSDF). The JASDF also has operated transports (C-130s and domestic C-1s), helicopters (CH-47Js and UH-60s), and airborne early warning and control aircraft (E-2Cs and a modified version of the Boeing 767). Additionally, the JASDF controls the homeland defense surface-to-air missiles (Nike-J and Patriot) while the GSDF controls the tactical SAMs (Hawks).

The missions of the JASDF have been territorial air defense, including surveillance and identification of violators of national airspace; air rescue; airlift operations; air traffic control and weather; and civil relief operations, both domestic and, after 1994, overseas, with major activities in Cambodia and Rwanda. The JASDF also collaborates with the MSDF in protecting the sea lines of communications, and it supports the MSDF and the GSDF in defending against invasions of the Japanese home islands.

Jerome V. Martin

Japanese Army Air Force, Imperial (JAAF)

The air force component of Japan's imperial ground forces during World War II. The Imperial Japanese Army Air Force finds its origins in 1877 with the use of balloons. In 1904, the army used balloons in the Russo-Japanese war, carrying out 14 successful missions.

Officially there were no organizational efforts until July 1909, when the Provisional Military Balloon Research Society was formed. This included members from both the army and the navy as well as staff from Tokyo Imperial University. The society purchased its first aircraft in 1910 and made its first flight on Japanese soil in December.

In December 1915, the army organized its aircraft into the Air Battalion, Army Transport Command. In 1919, Major General Ikutaro Inouye became the first commander of the Army Air Division. In 1925, the Air Corps was established and became an equal part of the army with the infantry, artillery, and cavalry.

The first major conflict that the Army Air Corps was involved in was the so-called Manchurian Incident of September 1931. The army had little trouble establishing air superiority over Chinese forces during the conflict.

From 1932 to 1937, a major modernization of the Air Corps occurred. At this time, the second Sino-Japanese conflict began. The army primarily concentrated aircraft on ground support duties while the navy fought for air superiority and handled long-range bombing operations.

Another concern during this time was the threat of the Red Air Force and the Manchukuo-Siberian border. After a bitter conflict with Soviet forces at Nomonhan, the Japanese began to develop aircraft to fight an eventual battle with the Soviets. These aircraft were designed to fight in the cold of the region, not for long missions over the great expanses of the Pacific.

Early in the Pacific War, the JAAF had many successes. It advanced with little opposition in most areas until July 1942, when it had reached its limit. From late 1942 until October 1944, it suffered increasing losses, particularly in New Guinea, to U.S. forces and in China to Chinese forces. These forces were being resupplied with newer and better aircraft, whereas the JAAF was still equipped with the aircraft it had started the war with.

Finally, in 1944 new fighters and bombers began to arrive. It was simply to late to do anything but slow the advance of the Allies. With the first B-29 missions that bombed mainland Japan, the army's focus shifted to homeland defense. The aircraft assigned to this mission lacked the high-altitude abilities necessary to be effective.

David A. Pluth

See also
Japanese Naval Air Force, Imperial

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Japanese Naval Air Force, Imperial (JNAF)

The air force component under the Imperial Japanese Navy during World War II. The birth of Japanese naval aviation occurred in 1912. The navy had been part of the Provisional Military Balloon Research Society, which had been established as a joint effort with the army. The army dominated the society, and the navy decided to withdraw and create its own organization, the Kaigun Kokujutsu Kenkyu Kai (Naval Aeronautical Research Association). This event would be a bone of contention between the army and navy for many years to come.

The naval association sent six officers to France and the United States to acquire seaplanes and learn to fly and maintain them. The operation was a success, and a new naval air station was established on the Oppama Coast near Yokosuka. Within the year, the Imperial Japanese Navy commissioned their first seaplane tender, the *Wakamiya Maru.*

In 1916, the first Navy Air Corps was activated, the Yokosuka Kokutai. In 1917, the first completely Japanese-designed aircraft was built at the Yokosuka naval arsenal.

After World War I, the navy became intrigued with the idea of launching aircraft from ships. In June 1920, a deck was mounted to the *Wakamiya Maru,* and a Sopwith Pup was launched successfully from the deck. Then, in late 1921, the *Hosho*—the world's first true aircraft carrier—was launched. Other ships had been modified to carry aircraft, but the *Hosho* was designed from the ground up to be an aircraft carrier.

It was not until 1932 that a major push was made to develop true carrier aircraft. The navy issued Specification 7-Shi for a carrier-based aircraft to be built. The navy had developed a system where it would submit a specification to a number of manufacturers, which would compete to have their design accepted for service. This specification was thought to be extremely important to the navy in its development of attack aircraft and fighters. However, only one aircraft, the E7K1 Alf, was placed into production in quantity. The failure was primarily due to high expectations and limited technology at the time. Two years later, navy specifications would be met, and the first of the dominant Japanese aircraft would start to appear in the arsenal.

It was about this time that the navy entered the second Sino-Japanese conflict. The results were outstanding. Japanese fighters and bombers forced the Chinese to withdraw their aircraft or lose them. There was also one additional benefit to the war with the Chinese. Beyond the experience gained, it gave the Imperial Japanese Navy a chance to further organize and develop effective air combat tactics. These would become very useful during the Pacific War.

Because of its collection of long-range aircraft and aircraft carriers, the navy would become responsible for all campaigns in the Pacific islands. It would also be responsible for the attack on Pearl Harbor.

In the first six months of the war in the Pacific, the navy was extremely effective. Its experience in China and its organization made it a formidable foe. However, in June 1942 at Midway Island, U.S. carriers dealt the navy a heavy blow, sinking four aircraft carriers. This loss of ships and aircraft stopped the Japanese advance in the Pacific.

At this point of the war, it appeared that the industrial production of the United States and the abundance of pilots available to Allied forces could not be equaled by the Japanese. Japan was quickly running out of trained pilots as well as materials to produce aircraft and ships.

In October 1944, the Imperial Japanese Navy developed a new tactic: kamikaze attacks. A kamikaze would dive his aircraft, loaded with bombs, into Allied ships. The tactic did minimal physical damage given the number of aircraft and pilots that it sacrificed. Hostilities in the Pacific War continued until August 1945, when the order for surrender was given. This spelled the end of the Imperial Japanese Navy until the postwar years.

David A. Pluth

See also
Nakajima Aircraft

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Jeschonnek, Hans (1899–1943)

The longest-serving Luftwaffe Chief of Staff. Jeschonnek became a pilot at the age of 17 and served with Erhard Milch during World War I. He remained in the interwar German army, the Reichswehr, and rose quickly in rank, especially after he and his mentor Milch joined the newly established Luftwaffe.

Jeschonnek became Luftwaffe Chief of Staff in February 1939 and rose to full general, but he fell out with both Milch and Hermann Goering, who blamed him for the operational failings of the Luftwaffe. Jeschonnek was well known for his enthusiastic, unquestioning obedience to Hitler but was unable to hold his own in the cutthroat competition for the Führer's favor. On the morning of 18 August 1943, the day after the USAAF's first raid on Schweinfurt and Regensburg, Jeschonnek received word of the RAF's damaging attack on the German rocket research facility at Peenemunde the previous night and then shot himself. He left the following note: "I can no longer work together with the Reichsmarschall [Goering]. Long live the Führer."

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Johnson, Clarence L. "Kelly" (1910–1990)

U.S. aeronautical engineer. As the founder and leader of Lockheed's legendary Skunk Works, Kelly Johnson became famous for building revolutionary aircraft under tight deadlines and maximum security.

Clarence Leonard Johnson was born on 27 February 1910 in Ishpeming, Michigan, the seventh of nine children born to Swedish immigrants. His Irish-sounding nickname was bestowed on him by grade school classmates on account of his fiery temper. From the age of seven or eight, he had access to his father's workshop, and he quickly showed mechanical aptitude.

The Johnsons were bitterly poor, and Kelly learned the lather's trade at age 12 to help support the family. The next year, the Johnson family moved 300 miles to Flint, where opportunities were better. There Kelly finished high school and attended junior college.

He went on to the University of Michigan, where he majored in aeronautical engineering. With a friend, he subcontracted for use of the university's wind tunnel and made enough money to cover school expenses by testing and modifying auto-body designs for Studebaker.

Johnson interviewed with Lockheed upon graduation in 1932, only to be told there were no jobs available. Advised to try again later, he went back to Michigan to earn a master's degree. Going to work for Lockheed in 1933, he worked with chief engineer Hall Hibbard to redesign the Lockheed Electra, adding a twin tail for improved directional control. The redesigned Electra was a technical and commercial success, assuring Lockheed's future.

After leading design teams for the Constellation transport and the P-38 Lightning fighter, Johnson teamed up with Hibbard again to build America's first jet aircraft, the P-80 Shooting Star. The demands of this program led to the creation of Lockheed's fabled Skunk Works, an experimental group under Johnson's direct supervision, where designers and workers could cooperate closely and red tape was eliminated. Here Kelly found his niche, revealing himself to be a brilliant manager as well as engineer. Intense, driven, and totally devoted to the job, he inspired his people to achieve much more than they might have in a more relaxed atmosphere. Johnson's leadership led to the completion of a prototype aircraft in an incredible 143 days from the signing of the initial contract.

Given a free hand at the Skunk Works, Johnson went on to lead the efforts to create the USAF's premier reconnaissance airplanes, the U-2 and the SR-71. Due in part to Johnson's passion for secrecy, both spyplanes flew successfully for several years before the public learned any details about the aircraft or their missions.

Johnson married Althea Young in 1937. She died of cancer in 1969, after encouraging Kelly to remarry. He married Maryellen Meade, his secretary, in May 1971. She died in October 1980 of complications from diabetes, also encouraging

One of the greatest aircraft designers in history, Kelly Johnson stands next to one of his prize productions, the Lockheed U-2. (U.S. Air Force)

Kelly to remarry. Declaring himself too old to waste time for appearance's sake, he married Nancy Horrigan a month later.

In 1986, he broke his hip in a fall. Apart from a trip to the Skunk Works to see an SR-71 take off one last time, he never left the hospital. His final years were heartbreaking, as a general physical decline and advancing senility devastated the proud, robust Johnson. He died on 21 December 1990.

Mark E. Wise

See also

Lockheed Aircraft; Lockheed F-104 Starfighter; Lockheed P/F-80 Shooting Star; Lockheed P-38 Lightning; Lockheed SR-71 Blackbird; Lockheed U-2

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Johnson, Robert S. (1920–1998)

U.S. World War II fighter ace. Robert S. Johnson was born on 21 February 1920 in Lawton, Oklahoma. He entered Army aviation in November 1941 and trained in Missouri and Texas before being assigned to fly fighters. In July 1942, he traveled to Bridgeport, Connecticut, to join Hub Zemke's Wolfpack, the 56th Fighter Group. After checking out on the new Republic P-47B fighter, he sailed for England on the *Queen Elizabeth* in January 1943.

Johnson scored his first aerial kill on 13 June, when he broke formation to attack a German Focke-Wulf fighter. Renowned for his phenomenal eyesight, superior marksmanship, and aggressive nature, his list of victories quickly grew. In only 91 missions flown from April 1943 through May 1944, he scored an impressive 27 victories, second in the European theater only to Francis Gabreski's 28. In June 1944, Johnson came home to a White House welcome and spent the remainder of the war touring and speaking in the United States. Johnson's decorations include the Distinguished Service Cross, Silver Star, and Distinguished Flying Cross.

After the war, Johnson worked for Republic Aviation and later became an insurance executive. In 1958, he collaborated with Martin Caiden on his autobiography, *Thunderbolt!* Johnson died on 27 December 1998 in Tulsa, Oklahoma.

Daniel Ruffin and Steven A. Ruffin

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Joint Strike Fighter (JSF)

The Joint Strike Fighter project is developing an aircraft that will serve as the primary attack aircraft for all three U.S. military services and replace the Harrier in British service. It is likely, assuming that the development effort is successful, that the JSF will enjoy widespread export potential to other countries; estimates run as high as 6,000 aircraft being produced, but 3,000 is the more likely number.

Three different variants of the JSF are under development: a conventional aircraft for the U.S. Air Force, a larger-wing variant for the U.S. Navy, and a vertical/short takeoff and landing (V/STOL) version for the U.S. Marines and Britain. The goal of the program is to make these three variants as similar as possible to minimize costs.

Two contractor teams developed JSF prototypes. One team led by Boeing built two X-32 demonstrators; the Lockheed Martin team built two competing X-35 aircraft. Both teams presented their aircraft to the public in early 2000 and flew them later that year. The winner, Lockheed Martin, was announced to great fanfare in October 2001. The contract to build the JSF, valued at some $200 billion, represented the largest defense contract ever awarded.

Dennis R. Jenkins

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Jointness

A U.S. military concept that calls for the separate services (Army, Navy, Air Force, and Marine Corps) working in concert to accomplish assigned missions. Although there has always been cooperation between the services, the passage of the Department of Defense Reorganization Act (more commonly known as the Goldwater-Nichols Act) in 1986 mandated integration of organizations, doctrines, resources, and command. This initiative evolved because of concerns over service parochialism and other issues that often played a major role in several less-than-successful military operations, such as the DESERT ONE debacle (the aborted

Iran hostage rescue mission) and Operation URGENT FURY (Grenada).

Under the concept of jointness, it is anticipated that no single service will operate alone. Rather, the services will work in concert as a unified team. Individual service perspectives, forces, and doctrines are integrated to increase the effectiveness of the entire force.

The Goldwater-Nichols Act strengthened the office of the Chairman of the Joint Chiefs of Staff and clarified the chain of command by stating that operational authority ran from the president to the secretary of defense and then directly to nine joint commanders in chief (who were assigned regional or functional areas of responsibility). The service chiefs and service secretaries were excluded from command responsibilities but were charged with recruitment, training, and equipping their service forces for the commanders in chief to use in carrying out operational missions.

James H. Willbanks

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Jones, David C. (1921–)

USAF general; one of the most important U.S. military leaders during the Cold War who figured in critical decisions of the period. Noted for his ability to bring together opposing points of view, Jones was especially valuable in bridging the requirements of different political administrations. Jones was the ninth Chief of Staff of the U.S. Air Force (1974–1978). He was also the ninth Chairman of the Joint Chiefs of Staff (1978–1982).

Commissioned from the aviation cadet program in 1943, Jones did not see combat in World War II, serving as a flying instructor. However, during the Korean War he flew more than 300 hours in B-29s, gaining the combat experience that made him valuable as an aide to Major General Curtis E. LeMay at Strategic Air Command headquarters. LeMay valued the qualities of the native of Aberdeen, South Dakota, and Jones soon found himself on a fast track to the top. His senior positions included commander of Second Air Force/SAC and commander in chief of U.S. Air Forces in Europe.

Jones was the champion of two highly controversial bomber programs, the North American XB-70 and the Rockwell B-1 and, as a result, became a controversial figure. The controversy became more intense when, as Chief of Staff, he reluctantly supported President Jimmy Carter's decision to cancel the B-1. This was at a time when he was pushing force improvements, which involved, among other things, significant reorganization within the USAF. One of his most important contributions was as an ardent advocate of one of the most valuable force multipliers in history, the Airborne Control and Warning System (AWACS).

As two-time chairman of the Joint Chiefs, he served in a number of important roles, including chairman of the SALT discussions and negotiator for the Panama Canal Treaty of 1978.

Jones retired in 1982 and went on to a very successful career in private life, expending much of his effort on improving educational materials.

Walter J. Boyne

See also

Strategic Arms Limitation Treaty

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Junkers Aircraft

German aircraft manufacturer. Hugo Junkers (1859–1935) established his first factory in 1889 to make engines and later heating devices. He patented a flying-wing metal airplane design in 1910 and was soon pioneering all-metal construction methods, building an experimental wing in 1915. The first use of corrugated light-alloy skin in an aircraft came with the J 4 of 1917 and marked Junkers products into the early 1930s.

In 1919, the J (later F) 13 appeared, designed to carry six passengers and widely used during the 1920s. It was the first purpose-built all-metal passenger airplane; more than 300 of various models were built. This was expanded into the three-engine G 23 and G 24 airliners of the mid-1920s. The last of the company aircraft before adopting the "Ju" prefix, the G 38 was a giant for 1929—designed to carry up to 30 passengers in the fuselage and wing compartments. Two were built, plus six in Japan under license. Junkers retired in 1932 and lost control of the company in 1934 to the Nazi government.

The separate airframe and engine concerns were combined in 1936. The Ju 160 single-engine airliner of 1934 carried six plus a crew of two. Nearly 50 were built. The Ju 86 was developed as a twin-engine bomber and airliner, first flying

At its peak during the Blitzkrieg period, the Junkers Ju 87 was eventually relegated to occasional ground attacks. (U.S. Air Force)

in 1934. More than 800 of various bomber models were built, compared to perhaps 60 civil airliners. The Ju 90 40-seat airliner first flew in 1937, and the 11 examples were transferred from Lufthansa to Luftwaffe service. About 55 Ju 290 four-engine reconnaissance aircraft were built, one of which flew round-trip from France to just short of New York City to test its long-range bombing capacity. Only two of the giant Ju 390 six-engine transports were built. The Ju 287 was the final Junkers product and the only jet aircraft. Its four Jumo engines were mounted in pairs–two on the forward-swept wing, two on the front fuselage. Only two were built. Some 140,000 workers were employed toward the end of the war.

Christopher H. Sterling

See also
Junkers Ju 52/3m, Ju 87 Stuka, and Ju 88

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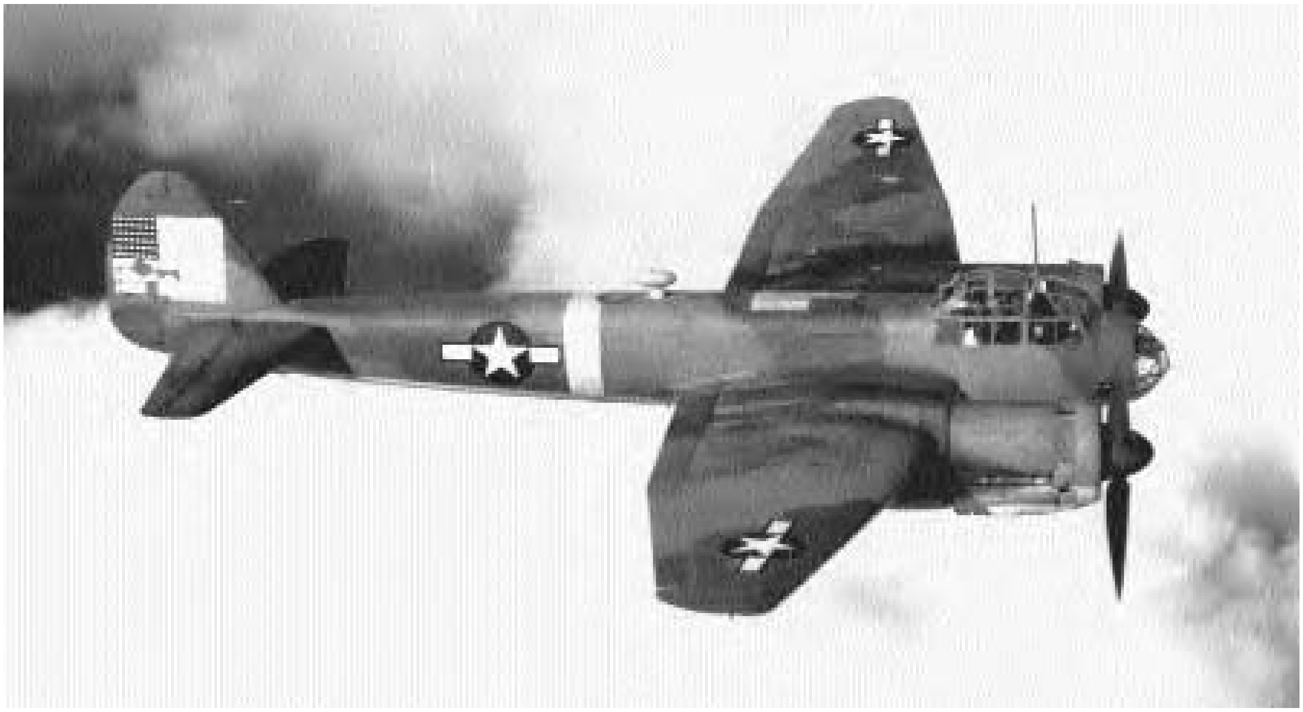
Junkers Ju 52/3m, Ju 87 Stuka, and Ju 88

First flown in May 1932, the German Junkers Ju 52/3 was a three-engine transport. Pilots favored its BMW trimotor design because it of its reliability. The early version, the Ju 52/3m, carried 15–17 passengers plus a crew of three and was sold around the world as a passenger airliner. When Germany began to rearm, Junkers modified the model and produced a bomber, the Ju 52/3mg3e. When the Spanish civil war broke out, the Kondor Legion and the Nationalist air force were supplied with Ju 52 bombers, troop transports, cargo transports, and air ambulances. The transport version had one 13mm machine gun in an open-air gun turret on the top of the plane near the tail and two 7.92mm machine guns that were manually aimed from the plane's windows; the bomber could carry a payload of 3,307 pounds. Junkers continued to make the transport version, which served the Luftwaffe until the end of the war.

The Junkers Ju 87 Stuka was a low-wing cantilever dive-bomber and ground attack aircraft. First flown in late 1935, the Ju 87A entered production in 1937 powered by the Junkers Jumo engine. The Stuka derived its name from the German for "dive-bomber"—*sturkampfflugzeug.* It was fitted during the blitzkrieg period with screaming whistles would terrify civilians when the aircraft was put into a steep dive. Main armament for this plane from 1939 to 1943 included two 7.92mm machine guns in its wings, one 7.92mm MG 15 machine gun in the rear cockpit (later replaced with an MG 81), and four 110-pound bombs on wing racks. Junkers built many different versions of the aircraft, including transporters and glider tugs, but its most successful ver-



One of the most versatile of the German aircraft, the Junkers Ju 88 was tested extensively at Wright Field during World War II and may today be seen, in its original German markings, in the Air Force Museum in Dayton, Ohio. (Gene Furnish)

sion was the Ju 87G1. This close-support aircraft's armament consisted of two 37mm BK Flak 18 or Flak 36 cannons mounted under the wing. As German air superiority faded, the thinly armored, slow-moving Stuka was relegated to occasional ground attacks.

The twin-engine Junkers Ju 88 first flew in late December 1936 and entered regular service in September 1939. Originally prototyped as a civilian transport, the Ju 88 could carry three to six crewmembers and a variety of armaments. Powered by either Junker Jumo or BMW engines, this highly maneuverable, well-built aircraft was one of the best in the Luftwaffe's arsenal. It filled many roles, including bomber, close support, reconnaissance, torpedo-bomber, trainer, and unguided missile. However, its most famous role was as a night-fighter against Allied bombers. The Ju 88 was still being produced when German factories were overrun in 1945.

Brian B. Carpenter

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K

Kaman Aircraft

U.S. helicopter manufacturer. In 1945, Charles H. Kaman formed Kaman Aircraft Corporation to manufacture helicopters. Having an aeronautical engineering degree from Catholic University, he began work for United Aircraft in 1940 designing propellers in the helicopter division. By 1943, he headed the aerodynamics department and worked to improve helicopter stability. His invention of a servo-flap rotor-control system to reduce vibration was not well received at United, so he formed his own company. His first helicopter, the K-125, was homemade. His second, the K-190, featured contrarotating and intermeshing dual rotors but no tailrotor, a design that gave great stability and lift.

In 1952, Kaman began manufacturing helicopters for the military. The U.S. Navy procured helicopters similar to the K-190 for training, utility, and medical evacuation. The Navy designated this helicopter HTK-1 and later TH-43E. In 1958, the Navy, Marines, and Air Force procured the K-600, an enlarged HTK-1. These services designated their models, respectively, the HUK, HOK, and H-43A Huskie. The Air Force acquired 193 Huskies and used them for rescue and firefighting. These helicopters were later converted from piston to turboshaft engines. Production ceased in 1965. In 1962, the Navy began receiving from Kaman 190 HU2K Seasprites for rescue and utility operations between ships. In the 1970s, the Navy converted 105 of these to antisubmarine warfare and designated them the SH-2 to serve in the Light Airborne Multipurpose System I (LAMPS I). LAMPS gave the Navy its first manned antisubmarine warfare helicopter capable of operating from ships other than aircraft carriers. In 1981, Kaman reopened helicopter production to provide the Navy with more SH2F Seasprites because some ships could not accommodate the SH-60B LAMPS III helicopter.

In the 1970s, Kaman Corporation diversified to lessen dependence on defense contracts. It developed a large aerospace distribution business in addition to aircraft production. Kaman's contributions to helicopter development included several firsts: a servo-controlled rotor, a gas-turbine engine, twin-turbine engines, composite rotor blades, and a remote-controlled helicopter.

John L. Bell

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Kamikaze Attacks

Desperate suicide attacks undertaken by Japanese pilots during World War II to deliberately ram Allied naval vessels. Kamikaze attacks often caused more damage than conventional bombs or torpedoes. The Japanese term *kamikaze*—"divine wind"—refers to a storm that destroyed a Mongol invasion fleet off Japan in 1281. It was the most common term used to describe these attacks in Japan, and the only term used by the Allies.

Kamikaze pilots did not consider their actions to be suicide attacks in a Western sense but rather the opposition of Japanese moral and spiritual conviction against Western scientific and material advantages. Many kamikaze pilots died with the utmost faith that their sacrifices would reverse the course of the Pacific War, and many wished to continue fighting—and dying—after the Japanese capitulation, though the final consensus was to respect the order to surrender.

By October 1944, Japan had lost the technological edge it had enjoyed in aircraft performance at the start of the Pacific War. In addition, attrition had left Japan with few expe-

A dreaded sight, and one of the most dangerous of the war: the end of a kamikaze's journey. (U.S. Navy)

rienced pilots. These factors combined to make successful conventional attacks on Allied ships rare. Although individual Japanese had crashed their planes into enemy ships and aircraft prior to this date (as had pilots from other nations, including the United States), it was the suggestion of Vice Admiral Onishi Takijino that such attacks become policy. Kamikazes were first operational in the Philippines campaign of 1944, sinking the U.S. escort carrier *St. Lô.* Kamikazes struck again at Iwo Jima, and at Okinawa kamikazes came in massed waves called *kikusui* (floating chrysanthemums). These attacks represented the high point of kamikaze operations. Additional aircraft were set aside to use in kamikaze attacks against the Allied fleet during the invasion of Japan but were never used.

Initial kamikaze attacks used existing types of aircraft. Later, modifications were made to allow heavier bombloads. Japan even went so far as to develop a rocket-driven, human-piloted bomb known as the "Okha" (Cherry Blossom) or "Jinrai" (Thunderbolt) to the Japanese and the "Baka" (Idiot) to Allied forces. The kamikaze concept expanded beyond aircraft to include manned torpedoes, explosive-laden motorboats, midget submarines, and finally the great battleship *Yamato,* which steamed from port with enough fuel to reach the Allied fleet but not—according to some accounts—with enough to return.

Although the kamikazes did cause considerable damage to the Allied fleet, sinking or damaging several hundred ships, the kamikazes were unable to reverse the course of the war. Most of the inexperienced pilots were shot down by veteran Allied fighter pilots well short of their targets or perished in a hail of antiaircraft fire. The rocket bombs made more difficult targets for Allied defenders but had to be carried into battle by slow, unmaneuverable bombers, which were often shot down short of their release point. Most of the seaborne kamikazes failed, and U.S. carrier aircraft sunk *Yamato* long before it neared any Allied surface vessel. It might even be said that the fanatical resistance exemplified by the kamikaze convinced U.S. leaders that nothing short of the atomic bomb could persuade Japan to give up the fight. Thus, the kamikaze may well have brought a new order of destruction to the Japanese people in their efforts to defend the homeland.

Grant Weller

See also

Atomic Bomb; Iwo Jima; Japanese Army Air Force, Imperial; Japanese Naval Air Force, Imperial; Okinawa; Philippines

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Kammhuber, Josef (1896–1986)

Luftwaffe general best known for establishing Germany's nighttime air defenses. Kammhuber was an infantryman in World War I. He was selected to join the interwar army, the Reichswehr, attended the school for General Staff officers, and in 1935 transferred to the Luftwaffe. He commanded a bomber wing in the early campaigns of World War II and was chosen in mid-1940 to set up the German defenses against nighttime Allied bombing.

The Kammhuber Line that he devised required the close control of each night-fighter by a ground operator and was successful until RAF Bomber Command decreased the spacing within its bomber streams and then blinded enemy radars with Window (chaff, or air-dropped aluminum strips). Kammhuber was slow to adapt his defenses to the new tactics and was relieved of his position on 15 September 1943. He was given no important command for the rest of the war. However, when the postwar Bundesluftwaffe (West German air force) was established in 1956, Kammhuber was named as its first commander in chief, with the rank of major general. He established the organization of the new service and integrated it into the defenses of Western Europe.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Kamov Helicopters

One of two Soviet design bureaus specializing exclusively in helicopters. Nikolai Ilich Kamov was born in 1902, in Siberia like his colleague Mikhail Mil. After completing technical school, Kamov first became a locomotive engineer, but in 1926 he became a pilot and soon turned to design work. In 1929, he was part of the design collective that created the first Soviet autogyro, and until 1945 he worked for a series of other design bureaus, sometimes with Mil as his assistant. In 1945, Kamov founded his own design bureau, the first in Russia dedicated exclusively to helicopters, and in 1947 he designed Russia's first practical helicopter, the Ka-8. The Ka-8, of which three were built, was intended for shipboard use. In 1954, 16 examples of the similar Ka-10 entered experimental naval service.

From the beginning, Kamov and Mil took different paths. Whereas Mil's designs were conventional and intended primarily for the army, Kamov designed exclusively for the navy and with only a couple of exceptions invariably used a coaxial contrarotating twin-rotor system. Kamov's first real success was the Ka-15, of which 354 were built from 1955 to 1959, used for shipboard reconnaissance, liaison, and training. From 1959 to 1961, 111 of the similar but slightly larger Ka-18s were built. The classic Kamov Ka-25 "Hormone" entered production in 1964. By 1972, when production ceased, 267 had been built, primarily as dedicated shipboard antisubmarine warfare (ASW) helicopters but also for aerial mining countermeasures, search and rescue, and midcourse flight correction and guidance for early naval cruise missiles. The Ka-25's success was in part the result of the commissioning of the Soviet navy's two helicopter carriers, the *Moskva* and *Leningrad,* and the development of new classes of cruisers and destroyers designed to utilize the Ka-25's capabilities.

From 1976, the Ka-25 was replaced by a new family of helicopters (code-named "Helix" by NATO). The basic version was the Ka-27, built in both antisubmarine-warfare and search-and-rescue variants, and the Ka-28, which was merely a version for export. The Ka-29TB was a heavily modified variant with nose armament and rocket pylons intended as an assault troop transport for Soviet naval infantry. By the late 1990s, almost 400 examples of these versions had been built, together with almost 150 of a dedicated civilian version, the Ka-32. In the mid-1990s, the Ka-31 (also called Ka-29RLD) was developed as a shipboard airnborne early warning helicopter, with a rotating dish beneath the fuselage.

In addition to building military helicopters, Kamov also built about 1,000 examples of the Ka-26 and its later developments, the Ka-126 and Ka-226, civilian helicopters for use as a crane, crop sprayer, and other uses.

In 1982, Kamov began development of a new single-seat attack helicopter, the Ka-50, in direct competition to Mil's Mi-28. Kamov has proven adept at public relations, naming the Ka-50 the "Black Shark" and sending it to air shows around the world in a dramatic black finish, where it performed aerial maneuvers, including true loops, previously considered impossible for helicopters. The Russian army decided to break with tradition and selected the Ka-50 in preference to the Mi-28 as its next-generation attack helicopter. This helicopter has also been marketed to the world, including NATO countries and even the United States. Kamov has developed a side-by-side two-seat version, the Ka-52 Alligator, which will function as both a combat trainer and (with advanced avionics) as an all-weather attack helicopter. The

Ka-60 is intended to be the army's next tactical troop transport and has forsaken the coaxial contrarotating rotor for a single main rotor and a tail unit much like the French Dauphin.

Nikolai Kamov died on 24 November 1973 and was succeeded by Sergei Mihkeev.

George M. Mellinger

See also
Mil Aircraft

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Kármán, Theodore von (1881–1963)

Mathematical prodigy from Budapest, Hungary, who became a U.S. physicist. He graduated in 1902 from Budapest University, working from 1903 to 1906 at the Technical University of Budapest. Von Kármán left Budapest to study at Göttingen and then in Paris, where he watched some pioneering aviation flights. Such flights piqued his interest to apply mathematics to aeronautics. In 1911, von Kármán made an analysis of the alternating double row of vortices behind a flat body in a fluid flow, a phenomenon now known as Kármán's Vortex Street.

The following year von Kármán accepted a position as director of the Aeronautical Institute at Aachen, Germany. Von Kármán visited the United States in 1926 and four years later accepted a post as director of the Aeronautical Laboratory at the California Institute of Technology. In 1933, von Kármán founded the U.S. Institute of Aeronautical Sciences, where he continued his research on fluid mechanics, turbulence theory, and supersonic flight. In addition, von Kármán studied applications of mathematics to engineering, aircraft structures, and soil erosion.

Albert Atkins

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Kartveli, Alexander (1896–1974)

One of the most important and innovative aircraft designers in U.S. history. Alexander de Seversky had founded the Seversky Aircraft Corporation in Farmingdale, New York. After Kartveli emigrated to the United States, Seversky almost immediately hired his fellow immigrant as chief engineer, and they proceeded to design a number of very advanced aircraft, including the SEV-1XP, which outperformed the Curtiss P-36 Hawk during a 1936 Army Air Corps competition. Known by the military designation P-35, it was the first modern U.S. Army fighter, incorporating a metal fuselage, low-set wings, retractable landing gear, and a radial engine.

In 1939, Seversky was removed as head of his company, and the Republic Aircraft Corporation was born. The first major aircraft to emerge from the new company was the P-47 Thunderbolt, using an innovative wing from the fertile mind of Kartveli. At the end of the war he designed a sleek flying photolab called the XF-12A, initially planned as a four-engine postwar transport; American Airlines canceled its orders, and only two prototypes were built for the Air Force. Postwar, Kartveli designed the F-84 Thunderjet/Thunderstreak, then led the team that developed the F-105 Thunderchief. He was also heavily involved with a 1960s-era Air Force project called Aerospaceplane—to design and build an orbital logistics vehicle—a decade before NASA attempted a similar concept (the Space Shuttle). The radical turboramjet-powered XF-103 was another stillborn Kartveli design, a victim of the propulsion community not being able to produce a suitable engine to power the Mach 3 interceptor.

Kartveli was never as well known as Kelly Johnson, his equal at Lockheed. But for the half-decade that Seversky and Republic manufactured aircraft on Long Island, Kartveli contributed significantly to the science of flight and the readiness of the U.S. military. Alexander Kartveli died in 1974.

Dennis R. Jenkins

See also
Republic Aircraft; Republic F-105 Thunderchief; Republic F-84 Thunderjet/Thunderstreak; Republic P-47 Thunderbolt; Seversky Aircraft

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Kawanishi Aircraft

Japanese airframe manufacturer. Kawanishi Kokuki K.K. was formed in 1928 after taking over the assets of Kawanishi Engineering Works. During World War II, Kawanishi was the sixth largest producer of combat aircraft in Japan. Kawanishi produced only airframes, with engines being provided by outside sources.

The Kawanishi George was a major step forward for Japan, as it was capable of meeting the U.S. Hellcat and Corsair on equal terms. Like all Japanese aircraft later in the war, however, it was handicapped by quality control problems. (U.S. Air Force)

Kawanishi had a total of four plants. Three—Himeji northwest of Kobe, Naruo near Osaka, and Konsan between Osaka and Kobe—produced airframes. The fourth plant (Takarazuka, located north of the Naruo plant) was a component plant that supplied parts to the others.

During World War II, Kawanishi produced three primary aircraft. The N1K Kyofu (Allied code name "Rex") was the first Japanese floatplane fighter specifically designed for that purpose.

The N1K1/2-J Shiden (Allied code name "George") was a land-based design developed from the Rex. From December 1942 to early 1945, some 1,000 aircraft of this type were produced. The highly maneuverable George was one of the few fighters at the end of the war that was a good match for the Allied F6F Hellcats and F4U Corsairs.

The H8K (Allied code name "Emily") was probably the best flying boat of the war serving any nation. The Emily was the largest of all naval aircraft and the fastest and most maneuverable flying boat in the Imperial Japanese Navy. The Emily carried out a variety of missions: reconnaissance, torpedo attacks, bombing, patrol, and transport. Approximately 160 Emilys were produced by the end of the war.

David A. Pluth

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Kawasaki Aircraft

One of the major Japanese industrial groups in the twentieth century. Kawasaki manufactured aircraft—including what many consider to be the best Japanese fighter of the war—before and during World War II and again after 1954.

Kawasaki Heavy Industries was formed in 1878 as Japan's first shipbuilder and in 1918 established an aircraft department—perhaps the first in the country. Initially, the company made substantial use of foreign personnel and designs at its Kobe headquarters. By 1920, it had built a factory and airfield. Its first government contract was for 300 copies of a license-built version of a Salmson reconnaissance aircraft for the army.

By 1923, Kawasaki had hired Richard Vogt (later with Blohm and Voss) as chief designer; he stayed for a decade and trained many others. Among his designs were the Type 88 biplane reconnaissance bomber (1927), of which more than 1,000 were manufactured; the Type 92 biplane fighter (1930), with nearly 400 made in two versions; and the Ki 3, the country's last biplane bomber (1933), some 240 being made.

After Vogt's departure the Ki 10, the last Japanese biplane fighter (1935), appeared (600 manufactured, some by Nakajima). The Ki 32 monoplane single-engine light bomber (1937) was also made in large numbers (850) and later became a trainer. In 1937, the aircraft branch was spun off into a separate firm; aircraft engines followed in 1939.

Kawasaki's wartime total production of 8,250 aircraft made it third among Japanese firms. The key aircraft included the 1939 Ki 45 twin-engine ground attack plane ("Nick" to the Allies) later used as an excellent night-fighter. About 1,700 were built, and four became the first kamikaze aircraft used in May 1944. The Ki 61 Hein (Swallow; "Tony" to the Allies) liquid-cooled fighter of 1941 was in service by 1943; some 2,600 were made.

Disaster can lead to unexpected innovation. One of the best Japanese fighters of World War II, the Ki 100, was the product of such an emergency. The manufacturer had 275 completed Ki 61 airframes when its engine factory was destroyed by Allied bombing. In desperate need of fighter aircraft, those airframes were modified to take a Mitsubishi radial engine rather than the intended Kawasaki inline motor. First flown in February 1945, the result startled its creators as one of the fastest and most maneuverable aircraft ever built. With a top speed of more than 365 mph, performance surpassed the Ki 61. The new models were in service by May. In June, manufacture began of the Ki 100–1b, with a cut-down rear fuselage and bubble canopy. Nearly 100 had been made by the end of the war. Three prototypes of an improved version were built just before the surrender.

The company was revived in 1954 to overhaul U.S. aircraft and develop its own new models. The latter included the C-1 high-wing twin-jet cargo plane (first flight 1970) and the T-4 jet trainer (first flight 1985).

Christopher H. Sterling

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Kearby, Neel (1911–1944)

United States Army Air Corps lieutenant colonel. Kearby was born on 5 June 1911 in Wichita Falls, Texas. He graduated in 1936 from the University of Texas and took flight training at Randolph and Kelly Air Force Bases.

In October 1942, Kearby was chosen as group commander of the 348th Fighter Group. He was disappointed to find out that there was little equipment and few pilots actually assigned to the 348th. After more than six months of preparations and training, Kearby and the 348th sailed for New Guinea and the air war against Japan.

There was some skepticism upon arrival that the P-47 Thunderbolt was not the proper aircraft for the job in the South Pacific. Through a series of mock dogfights with the P-38 Lightning, Kearby proved the P-47 to be a fighter that could hold its own and even dominate the best aircraft of its time.

Kearby scored his first two victories on 4 September 1943 by shooting down a Japanese fighter and a bomber. Kearby was awarded the Medal of Honor for his actions of 11 October 1943. Kearby shot down six Japanese aircraft while leading a flight of four aircraft over Wewak.

Kearby was killed in action on 5 March 1944. While on a sweep of the Wewak area, he and his flight shot down three bombers when one of the escort fighters, a Nakajima Ki 43 "Oscar," opened fire at short range and shot down Kearby. He had achieved the status as one of the top U.S. aces, with 22 victories in a six-month period.

David A. Pluth

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Kenney, George (1889–1977)

United States Army Air Corps/Air Force general. George Churchill Kenney was born in Yarmouth, Nova Scotia, on 6 August 1889. From 1907 to 1911, he attended the Massachusetts Institute of Technology. In June 1917, he enlisted in the Signal Corps Aviation Section, and by December 1917 he was commissioned as a first lieutenant. In 1919, Kenney was promoted to captain and became the commanding officer of the 91st Aero Squadron. From 1926 until 1935, Kenney served in a variety of assignments; in March 1935 he was promoted to lieutenant colonel.

Kenney was next assigned to Wright Field, Ohio, as chief of production. In 1940, he was promoted to colonel and sent to France as the assistant air attaché. Kenney was promoted to brigadier general in January 1941 and to major general in February.

In March 1942, Kenney was assigned to be commanding general of the Fifth Air Force. Kenny became General Douglas MacArthur's top air aide and commander of the Fifth Air Force in July 1942. In October 1942, Kenney was promoted to lieutenant general. Kenney led the air war against Japan in the Southwest Pacific through the end of the war. Kenney was promoted to full general in March 1945.

Postwar, Kenney was assigned to the Military Staff Committee of the Joint Chiefs of Staff and continued in that position until March 1946. In April 1946, Kenney was named commanding general of Strategic Air Command and served in that capacity until 1948, when he was named commandant of Air University. Kenney retired in August 1951. He passed away on 9 August 1977.

David A. Pluth

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Kesselring, Albert (1885–1960)

Luftwaffe commander best known for leading the tenacious Axis ground defense of Italy. Kesselring spent World War I as an artillery officer and on divisional and corps staffs. He was retained in the Reichswehr, the interwar army, where he gained a reputation for his administrative skills.

He transferred to the Luftwaffe in 1933, two years before its existence was openly acknowledged, and was named its Chief of Staff after the death of his predecessor. In 1937, he left Berlin for his first operational posting as an airman and spent the first years of World War II in command of Luftflotte 1 (First Air Force) and Luftflotte 2. He was promoted to field marshal in 1940 during the Battle of Britain.

When Luftflotte 2 transferred from the Eastern Front to the Mediterranean in December 1941, Kesselring gained an additional responsibility—that of *Oberbefehlshaber Sued* (commander in chief, Southern Front). His diplomatic skills were tested fully in dealing with Erwin Rommel, his field commander, and with his allies, the Italians. He succeeded Rommel as field commander in early 1943, retaining his higher command, and conducted a skillful fighting retreat up the Italian Peninsula from September 1943 to March 1945, when he replaced Karl von Rundstedt as *Oberbefehlshaber West* in Germany. The Western Front was already in the process of collapsing, and Kesselring surrendered his forces on 7 May.

Kesselring was condemned to death in 1947 as a war criminal, but his sentence was commuted to life imprisonment, and he was released from prison in 1952. His career was the most varied of any World War II air force general, and his record in Italy ranks him among the top defensive ground commanders of the war.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Khalkin Gol Air Battles (1939)

Also known as Nomonhan, the eastern tip of Mongolia saw a clash between the Soviet Union and Japan beginning on 10 May 1939 as a minor border disagreement and escalating to involve multidivision forces on both sides before ending on September 16. Although the Soviet ground forces decisively defeated the Japanese army, the Imperial Japanese Army Air Force managed to dominate the Red Air Force.

Initially, the Soviets had only 82 aircraft in Mongolia; the Japanese had about 500 aircraft available, but they committed only 32 at the start. Both sides rushed in reinforcements, leading to the largest air battles since 1918, often involving more than 100 aircraft on each side. The Soviets found they were suffering a 3:1 loss ratio and dispatched their most successful veterans of Spain. During the fighting the Soviets introduced the I 153 biplane, the cannon-armed version of the I 16, and made the first ever use of the RS-82 rocket in an air-to-air role.

Throughout the battle both sides exaggerated their claims. The Soviets claimed 645 victories for 207 losses, and the Japanese claimed 1,260 victories 162 losses.

George M. Mellinger

See also

Japanese Army Air Force, Imperial; Nakajima Aircraft; Polikarpov, Nikolai N.; Smushkevich, Yakov "General Douglas"; Tupolev Aircraft

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Khe Sanh

North Vietnamese attack against U.S. Marine Corps outpost. As the Vietcong attacked in South Vietnam during January 1968, North Vietnamese Army (NVA) regulars conducted a campaign of their own just south of the demilitarized zone (DMZ). General Vo Nguyen Giap organized an attack against the Marine outpost at Khe Sanh. Giap was attempting to recreate the conditions and success of Dien Bien Phu (the victory against the French in 1953), and for this purpose he employed two NVA divisions with a third in reserve. In this confrontation, the Marine garrison and the devastating array of U.S. Air Force munitions defeated the NVA.

The Khe Sanh base, located in northwestern South Vietnam 6 miles from the Laotian border and 14 miles south of the DMZ, posed a threat to the Ho Chi Minh Trail that linked North Vietnamese supply depots with communist forces deployed in South Vietnam. The place was difficult to defend: A chain of hills overlooked the plateau from the north and northwest, and drinking water came from a river that passed through enemy-controlled territory. Early in the year fog shrouded the base on most mornings, complicating air operations and limiting visibility from defensive positions.

In anticipation of a siege that would last for more than 70 days, the Marines quickly buoyed their forces at Khe Sanh to 6,000. Over the ensuing weeks the enemy steadfastly shelled the base and attempted to overrun it. One of the largest attacks was launched on 29 February. Previously planted electronic sensors first alerted defenders. In the ensuing encounter the Marines and their allies called upon mortars, artillery, tactical aircraft, and B-52 heavy bombers to create a barrier of high explosives at various approaches. The attack faltered before the enemy reached the berm line, and within two weeks U.S. intelligence reported that the NVA troops were withdrawing from the area. On 1 April Operation PEGASUS, the land advance to Khe Sanh, commenced and Khe Sanh was soon relieved.

Khe Sanh would not become Dien Bien Phu. Indeed, compared to the ill-fated French base, Khe Sanh was generously supported by artillery and air. More than 150,000 artillery and mortar shells were fired in defense of the Marine base and during Operation NIAGARA (the supporting the battle with both tactical air and B-52s), and a variety of aircraft dropped some 100,000 tons of bombs during round-the-clock attacks in all sorts of weather. The B-52s would perform 2,548 sorties and drop 53,162 tons of bombs. In addition, U.S. transport aircraft effectively sustained the garrison with more than 12,430 tons of supplies.

Compared to U.S. casualties (199 killed and 1,600 wounded) at Khe Sanh between 20 January and 31 March 1968, hostile forces suffered some 10,000 casualties (dead and wounded). President Lyndon B. Johnson claimed Khe Sanh as a victory. When awarding the Presidential Unit Citation to the 26th Marines, the president paid tribute to the "most overwhelming, intelligent, and effective use of airpower in the history of warfare." He further saluted the "endurance—and the artillery—of the Marines at Khe Sanh." But perhaps General William C. Westmoreland's assessment is much more apropos: He concluded that the "key to our success at Khe Sanh was firepower, principally aerial firepower." As he would tell the Third Air Division personnel at Andersen Air Force Base on 13 June 1968, "The thing that broke their backs was basically the B-52s."

George M. Watson Jr.

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Khomyakova, Valeriya (1914–1942)

Russian female military aviator in World War II. Valeriya Khomyakova was one of the women who volunteered to fly in the Soviet Women's Air Regiments in 1941 and was assigned to the 586th Fighter Aviation Regiment, where she

Valeriya Khomyakova was the first woman to shoot down an aircraft at night. Given the marvelous service of Soviet women in aviation, it is amazing that it took the rest of the world (include the postwar Soviet Union) so long to begin using women pilots. (Jean Cottam) was appointed deputy squadron commander. On the night of 25 September 1942, she intercepted and shot down a German bomber over Stalingrad. This was the first victory achieved by a woman pilot at night (Klavdiya Nechaeva and Lidya Litvyak both had scored day victories). She was killed in a flying accident on the night of 5–6 October 1942.

George M. Mellinger

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Khryukin, Timofei T. (1910–1953)

Soviet air force general in World War II. Timofei Timofeevich Khryukin was born on 21 June 1910 in Eisk, Russia. He joined the army in 1932 and completed flight school the next year. In 1937 and 1938, he flew the Tupolev SB as a volunteer in Spain and then China. He received the Hero of the Soviet Union award on 22 February 1939. At the start of the German invasion in World war II, he commanded the air units of the Twelfth Army in the Kiev Military District. In June 1942, he became the first commander of the Eighth Air Army, fighting on the Southwest Front and later the Stalingrad Front, where he proved an unusually effective commander. In May 1944, he was promoted to colonel general. From June 1944, he was commander of the First Air Army on the Belorussian Front. On 19 April 1945, he received a second Hero award. After the war he served as deputy commander in chief of the air forces. He died on 19 July 1953.

George M. Mellinger

See also

Soviet Volunteer Pilots; Stalingrad, Battle of

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Kindelberger, James H. "Dutch" (1895–1962)

U.S. aircraft designer and airpower advocate; general manager and chief executive officer of North American Aviation who championed the initial design and development of what became the P-51 Mustang fighter of World War II.

Born on 8 May 1895 in Wheeling, West Virginia, Kindelberger attended the Carnegie Institute of Technology but left to become an Army pilot upon U.S. entry into World War I. He became an instructor pilot based at Park Field in Memphis, Tennessee. Following the war, Kindelberger joined the Martin Aircraft Company as chief draftsman and assistant chief engineer. In 1925, he joined Douglas Aircraft in California as chief engineer, aiding in the development of the DC-1 and DC-2.

In 1934, Kindelberger became president and general manager of General Aviation, later renamed North American Aviation, Inc. At first the company concentrated on modification work to other manufacturers' products, but it offered its first original design, the NA-16 trainer, to the government and won that contract. Following that success, the company produced a string of aviation classics.

North American's most famous design, however, was the P-51 Mustang fighter. Originally offered to the British by Kindelberger as an alternative to the Curtiss P-40, the P-51 was designed and produced in less than 120 days. When eventually paired with the Rolls-Royce Merlin engine, the P-51 became one of the best fighters of World War II.

James Kindelberger served as chief executive officer of North American until 1960. During that time, the company transformed from an aircraft manufacturer to a prime contractor for the space program. He remained chairman of the board until his death on 27 July 1962.

Braxton Eisel

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King, Ernest Joseph (1878–1956)

U.S. Chief of Naval Operations during World War II. Born in Lorain, Ohio, on 23 November 1878, King attended the U.S. Naval Academy, saw service as a midshipman aboard the USS *San Francisco* during the Spanish-American War, and graduated with his commission in 1901. Up through World War I, he served on cruisers and battleships, commanded the destroyers *Terry* and *Cassin,* and was Chief of Staff to the Atlantic Fleet's commander.

In 1922, King underwent submarine training. He subsequently commanded Submarine Division 3 and the submarine base in New London, Connecticut. In 1926, he made another major career change, becoming a naval aviator at the advanced age of 48. King's aviation career included command of the carrier *Lexington.* He was chief of the Bureau of

Aeronautics and the Patrol Force, U.S. Fleet. He was promoted to rear admiral in 1933.

In February 1941, King was promoted to full admiral and assigned as commander in chief, Atlantic Fleet. In that position he oversaw initial convoy and antisubmarine efforts prior to the declaration of war with Germany. Following actual war in December 1941, King was named commander of the entire U.S. Fleet, as well as Chief of Naval Operations. He served in these roles throughout the war, the only person to hold both posts simultaneously.

King's position on both the U.S. Joint Chiefs and the Allied Combined Chiefs of Staff placed him at the critical juncture of U.S.-Allied policy and strategy. Despite the approved Allied strategy (Germany First), King remained a powerful advocate for increased naval emphasis on the war against Japan. He was equally determined to limit the impact of Allied desires on U.S. strategy, which made him very unpopular with his British counterparts. Nevertheless, King heavily contributed to virtually all of the major Allied conferences. If nothing else, King's repeated insistence that the U.S. Navy stay on the offensive against Japan made Admiral Chester Nimitz's successful operations possible. Moreover, King provided his subordinate in the Pacific with superb strategic guidance and, when possible, also diverted invaluable combat and amphibious forces in that direction.

King's unwillingness to cooperate with the British in the Battle of the Atlantic was perhaps his only serious strategic misstep. The Navy's tenfold growth during this period, however, while simultaneously winning a two-ocean war, was ample evidence of King's overall brilliance as a strategist and logistician. King was promoted to five-star rank in late 1944. Nimitz, his former subordinate, replaced him as Chief of Naval Operations in December 1945. King subsequently served as a naval adviser to the president and the secretary of the Navy until his death in Portsmouth, New Hampshire, on 25 June 1956.

Michael S. Casey

See also

Atlantic, Battle of the; Leahy, William D.; Nimitz, Chester William

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Kites

The use of kites can be traced back to imperial China. One account claims that a Chinese general, Han Xin, flew a kite over enemy position round 200 B.C.E. to measure the distance between his position and the enemy's walls. He then had a tunnel dug slightly longer than the length of rope used, reaching under the walls to enter the city.

Elsewhere in Asia, kites were used in religious rituals in Korea and among the Maori. The appearance of the kite in Europe is subject to conjecture. Some records suggest that the Roman armies of Trajan used a windsock contraption that hissed as it burned, instilling fear in enemy troops.

The modern kite seems to have been inspired from the Chinese design. The kite wasn't used in Europe until the sixteenth century, and then only for entertainment. By the nineteenth century, in parallel to ballooning experiments and recreational kites (a kite club existed in Philadelphia in the 1830s), several pioneers took to developing a science of kite-flying. Sir George Cayley was the first to study the aerodynamics of kites when he designed glider models. Alexander Graham Bell investigated the possibility of a radial-shaped kite.

The most successful pioneers were Lawrence Hargrave, who in 1894 succeeded in rising while suspended to a "kite train" in 1896 and 1898; and Louis Baden-Powell, who completed a similar experiment, reportedly rising above 200 feet. In addition, Captain William Cody used the principle of large kites to carry an entire camera operated by a timing device.

Several experiments were carried out to test the feasibility of using manned observation kites for military purposes. The U.S. Navy sent several officers to Hempstead, Long Island, to learn of the advantages of manned kites from Samuel F. Perkins.

In France the military saw little use for kiting, preferring instead to focus on the potential of ballooning. Soon however, reports that the Cody type could carry a camera prompted similar experiments on the continent. Indeed, aerial photography from a balloon was extremely expensive and time-consuming, so attaching a timing device to a camera was attractive.

In 1910, the French war ministry went one step farther and asked Captain Jacques Saconney to design a kite train capable of lifting an observer up to 1,800 feet. Despite successful tests, the war interrupted these experiments in favor of tethered balloons and blimps, considered more stable.

During World War II, kites were used as aerial targets by U.S. forces, the idea arising from Paul Garber, who would become famous as a curator at the Smithsonian Institution.

Guillaume de Syon

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Kittinger, Joseph W., Jr. (1928–)

One of the first Americans to experience the harsh environment of space; in 1957 he piloted a balloon to 70,000 feet in the USAF's Project Manhigh. His objective was to test life-support equipment for use in high-altitude programs. Kittinger had been working with Dr. John Paul Stapp when selected to test-pilot the Manhigh balloon.

Manhigh proved that, given proper protection, man could survive in space. Kittinger's second balloon project was Excelsior. The purpose was to test the new Beaupre parachute for high-altitude uses such as the U-2 spyplane.

The Beaupre incorporated a small stabilization chute that would open 16 seconds after ejection. This would prevent a flat spin and allow Kittinger to return safely to earth. Two test jumps were made from above 70,000 feet. Excelsior III took Kittinger to 102,800 feet, at which point he exited the gondola from "the highest step in the world." The chute worked, and Kittinger fell safely to earth, having fallen at speeds in excess of 700 mph, becoming the only human being to break the sound barrier without a vehicle.

Kittinger has gone on to many other aviation accomplishments. During 11 months as a North Vietnamese POW after being shot down, he formulated plans for what in 1984 became the first solo transatlantic balloon crossing. Still very active in the aviation community, Kittinger was inducted into National Aviation Hall of Fame in 1997.

Erich Streckfuss

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Koldunov, Aleksandr (1923–1992)

Soviet World War II fighter ace and later commander of the PVO (Antiaircraft Defense Forces). Aleksandr Ivanovich Koldunov was born on 20 September 1923 in Moshchinovo, Russia. He completed flight school and joined the 866 IAP (Fighter Air Regiment) flying Yak fighters on the Southwestern Front in May 1943. During the war he flew over Ukraine, the Balkans, and finally Hungary. He was recognized as a Hero of the Soviet Union on 2 August 1944. By the end of the war Captain Koldunov flew 412 sorties and fought 96 air combats, scoring 46 individual victories and one group victory. He was awarded a second Hero honor on 23 February 1948. On 7 November 1944, he was involved in an incident when USAF P-38s of the 82d Fighter Group mistakenly attacked a Soviet armored column northwest of Belgrade and fought an air combat with the protecting Yaks. During this combat Koldunov shot down three P-38s before ending the combat.

After the war Koldunov was assigned to the PVO and held a number of sensitive posts. In 1978, he was promoted to marshal of aviation and appointed commander of the PVO and a deputy minister of defense. Koldunov's term was marked by a number of incidents, including the destruction of Korean Air Lines Flight 007 over the Sea of Japan on 1 September 1983 with the loss of 269 lives. The final blow to the marshal came on 28 May 1987, when Mathias Rust flew his Cessna from Helsinki at low level to land in Red Square. Koldunov resigned two days later. He died on 7 June 1992.

George M. Mellinger

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Koller, Karl (1898–1951)

The Luftwaffe's last Chief of Staff. Koller volunteered for service in the Bavarian army at the start of World War I and served as a pilot on the Western Front after learning to fly. Koller joined the Bavarian state police in 1920 and did not reenter the armed forces until 1936, when he joined the Luftwaffe as a major. His entire Luftwaffe career was spent as a staff officer. He was promoted from Luftwaffe director of operations to Chief of Staff when Werner Kreipe was sacked by Hitler in November 1944.

Like his predecessor, Koller was disgusted with his superior, Hermann Goering, but he managed to keep his now meaningless post until war's end. His last rank was lieutenant general; his last official duty was to fly to Berchtesgaden to notify Goering of Hitler's decision to die in Berlin. Goering's carefully worded message to Hitler—inquiring whether this meant that Goering was to take over the government—was apparently suggested by Koller but resulted in Goering's house arrest and the loss of all his titles.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Korean War

The Korean War began on 25 June 1950 and lasted until 1953. The North Korean People's Army, equipped with Soviet weapons, crossed the 38th Parallel to take over South Korea. The U.S. military presence in the Far East was undermanned, and its equipment was outdated with the exception of the Air Force, which had a mixture of World War II piston-engine aircraft and a reasonable number of Lockheed F-80 jet fighters. The North Koreans and their Soviet advisers were under the impression that President Harry Truman and the United States did not consider South Korea to be within the U.S. sphere of influence.

The United States used airpower to slow down, then stop, the invaders. On 26 and 27 June, the top priority was to evacuate U.S. citizens and t-p ranking South Korean officials out of Seoul. A Norwegian freighter happened to be in Inchon Harbor, getting most of the people out on the first day. The remainder of personnel were flown out by C-54 transports on 27 June. On that day the North Korean air force made an aggressive move to interrupt the air traffic in and out of Kimpo Air Base (Seoul).

The only air cover available was from several flights of F-80s and a flight of North American F-82 Twin Mustangs, one of which scored the first victory of the Korean air war. U.S. jet aircraft lacked the necessary range for combat over Korea. After a flight from Japan, they had only a few minutes over the target area. As a stopgap, the tiptanks were increased in size to give the F-80s additional flying time.

The momentum of the North Korean forces allowed them to compress the UN forces into a narrow perimeter around Pusan. The perimeter defenders were sustained by aircraft of the Far East Air Force, which provided close air support and interdiction of supplies. On 15 September, General Douglas MacArthur used the newly arrived 1st Marine Division to make a daring amphibious landing at Inchon. This caught the North Korean military completely off-guard, and a lightning-fast thrust to the east by the Marines cut off enemy supply lines. The result was a mass retreat by the North Koreans and breakout from the Pusan perimeter.

Three weeks after the Inchon landing, the U.S. Eighth Army was crossing the 38th Parallel with orders to keep going. During late September, the B-29 Superfortresses began the systematic destruction of North Korea's industrial assets. On 19 October, ground forces entered the North Korean capital of Pyongyang. By this time, the UN air armada was destroying everything that moved, with only a very limited amount of equipment escaping into Manchuria.

The Korean War took a different course when, after many warnings that it would intervene, the Chinese People's Army crossed the frozen Yalu River in vast numbers. On 3 November, General Walton H. Walker ordered his Eighth Army to begin withdrawing to the south. The Soviet-built swept-wing MiG-15 appeared in significant numbers during November, and for the first time communist forces threatened to gain air superiority. The 4th Fighter Wing was rushed in, with their new North American F-86 Sabres, to counter this threat. This began the long series of F-86–versus–MiG-15 battles in the notorious MiG Alley near the Yalu River.

By Christmas Day 1950, more than 500,000 Chinese troops had pushed UN forces out of North Korea, crossing the 38th Parallel. On 14 January 1951, the Chinese were halted right after they captured Wonju, and this became the farthest point into South Korea that they would achieve. U.S. aircraft were working around the clock to halt the flow of supplies out of Manchuria, and by early February the results were beginning to show as some areas along the front lines began to sag and the Chinese began to fall back.

By late spring 1951, the lines had stabilized and a battle of position began that would last another 27 months. By now the opposing ground forces were well dug in, and neither side could gain much ground and hold it. The Chinese held the edge in manpower, and the UN forces held the edge in firepower. This situation could change only if the enemy were able to accumulate enough supplies to initiate a substantial offensive. With this in mind, UN airpower continued to destroy anything that moved southward. The spectacular aerial duels between the F-86 and MiG-15 continued, for it was essential for UN forces to maintain air superiority, allowing their bombers and fighter-bombers to operate almost with impunity. The Chinese knew they had no chance to gain ground if they couldn't move enough supplies to sustain a major offensive, so all movement had to be carried out at night. This was countered by USAF Douglas B-26 and Marine night-fighter aircraft interdicting trains and truck convoys.

Although airpower could not win the Korean War for the United Nations, it did neutralize the communist forces and force the communist leadership to enter an armistice. On 10 July 1951, truce negotiations began at Kaesong. They were moved over to Panmunjom on 12 November 1951, where they would remain until the war ended. For the first few months there were high hopes that the war would end soon, but these meetings would continue on and off for the next two years, with the Korean War officially ending on 27 July 1953.

Warren E. Thompson

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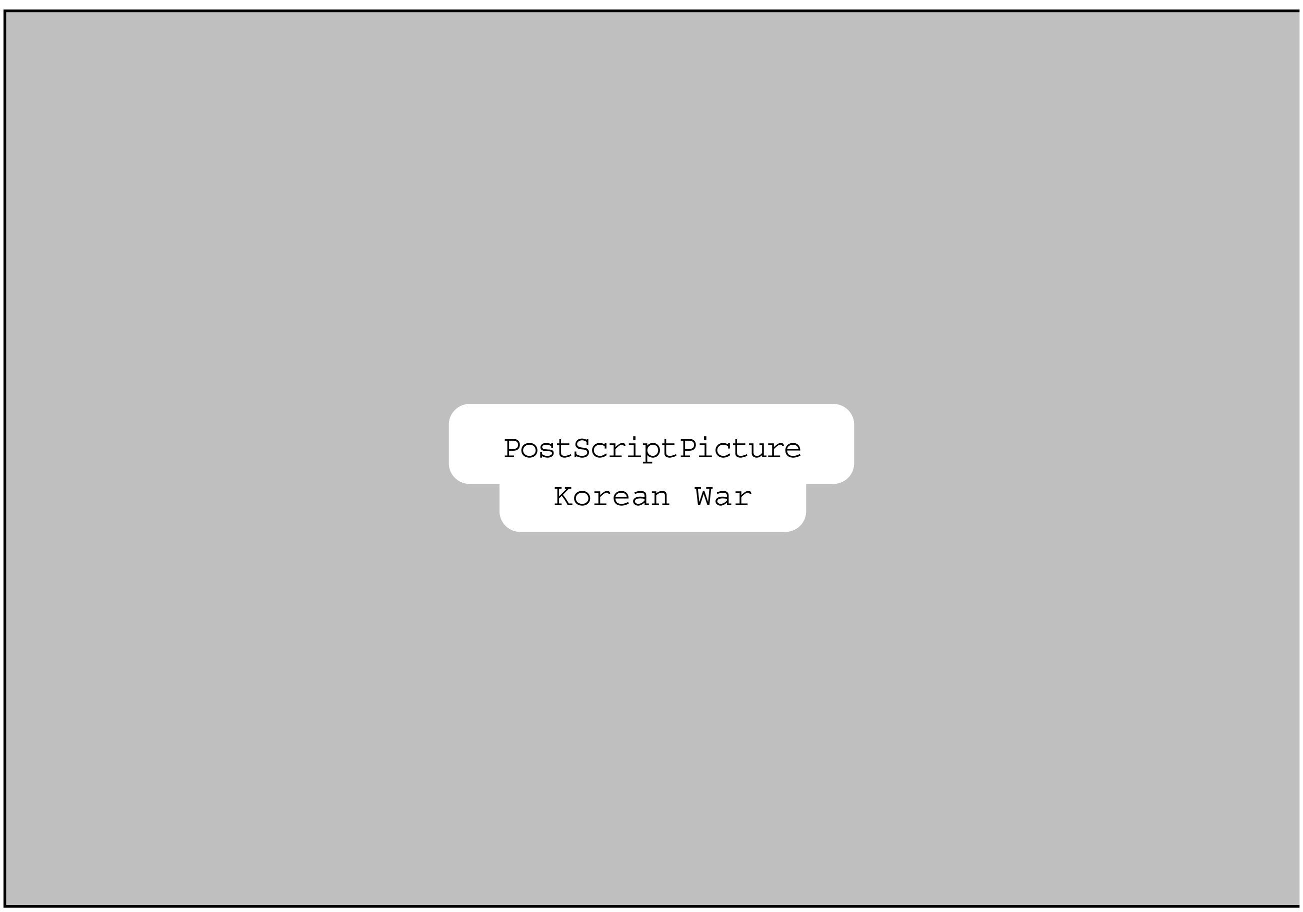
After the introduction of the MiG-15 fighters by the Soviets, the North American F-86 Sabres were brought in to combat them, spawning a long series of furious battles. (Smithsonian Institution)



Korolyov, Sergei (1907–1966)

Ukrainian-born aeronautical designer. Sergei Korolyov became interested in aeronautics when he witnessed a flight demonstration over Kiev in 1913. He studied in vocational school, graduating in 1924, and enrolled at the Kiev Polytechnic Institute to study aeronautics before transferring to Moscow Higher Technical School two years later.

By 1929, Korolyov had distinguished himself in glider design, and Andrei Tupolev served as his thesis adviser. Over the following two years he developed an interest in space travel and worked with Friedrickh Tsander, a pioneer of rocket-motor design.

In 1933, he became deputy engineer to the Reaction Propulsion Institute; although it included many space enthusiasts among its members, it was geared toward devising military applications for rockets. In 1934, Korolyov conceived the design of a winged rocket and began studying the problem of automatic stabilization. However, in 1938, during the Stalinist purges, Korolyov was arrested and sentenced to 10 years on trumped-up charges. Incarcerated in Siberia, he was moved around and continued to work in rocket design until his release in 1944. A year later, commissioned a colonel in the Red Army, he flew to Germany to evaluate the V-2 rocket.

Over the following five years, Korolyov extrapolated German technology and improved on the knowledge gained from a small team of German engineers. After indigenously producing the R-1, a copy of the V-2, Korolyov then focused on ballistic missile design. His R-2 model was a 20-ton missile that could fly over 300 miles. The R-3 design failed, but the R-5 (identified in NATO publications as the SS-3 "Shyster") reached well over 700 miles.

Korolyov, who now headed an important design bureau (OKB-1), also had to oversee an enormous staff of engineers and deal with political imperatives at the same time. This meant that he often needed to check for problems in designs himself, as many collaborators, fascinated with their chief, dared not point out shortcomings in tests. He was ordered to focus on a long-range intercontinental ballistic missile. Korolyov and his team came up with what would become the one-and-a-half stage ICBM R-7 Semyorka. Propelling a test warhead some 4,000 miles in August 1957, it became known as the SS-6 Sapwood and would be used in modified form to propel Soviet space vehicles into orbit. This included Yuri Gagarin's Vostok mission, as well as Voskhod.

Korolyov's great passion since he began designing space vehicles had always been to reach the moon and Mars. Consequently, he began planning the three-stage R-7 but also oversaw other designs intended to send unmanned spacecraft to Venus. By then, Korolyov was the dean of spacecraft design in the Soviet Union; as such, he had to face challenges to his supremacy based on politics, finances, competing programs, and jealousy. One such case was the dual development of a moon rocket for the transport of two or three cosmonauts.

Although he oversaw the initial design, Korolyov's untimely death from cancer prevented him from overseeing testing of the behemoth N-1 rocket. It is unclear whether his presence would have helped prevent the failure of the project, but it is certain that his absence contributed to the Soviet lunar program's demise. Korolyov was a household name in Soviet military and aerospace circles, but his identity remained classified for years. No pictures of him alone appeared until his death. The Nobel Committee, intent on honoring the scientist who had made Gagarin's flight possible, inquired in 1963 about his name and status, only to be told that the inventor of the booster was the Soviet people.

Guillaume de Syon

See also

Gagarin, Yuri; KOSMOS; Sputnik; Voskhod; Vostok

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Korten, Guenther (1898–1944)

Luftwaffe Chief of Staff. Korten served as an engineering officer in World War I. He remained in the service, trained as a pilot, and was an early transferee to the Luftwaffe, where he served in a variety of positions and rose rapidly through the ranks. He left Berlin to take command of Luftflotte 1 (First Air Force) and was named to succeed Hans Jeschonnek after the latter's suicide in August 1943.

He proved to have a more forceful personality than Jeschonnek and took strong positions on Luftwaffe operations and equipment. This aroused the wrath of Hermann Goering, and Korten was apparently to be forced to resign his position, but his career was cut short by the 20 July 1944 attempt to assassinate Hitler by means of a briefcase bomb. The blast fatally injured Korten, who died two days after his promotion to full general.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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KOSMOS

Kosmos is the Russian word for "space" and has been used to refer to any Soviet or Russian spacecraft whose purpose (scientific, military, or otherwise) does not fit into the parameters of established programs, such as Vostok, Voskhod, or Soyuz. In addition, one type of satellite launcher constructed in Ukraine and based on the R4 IRBM launcher also bore the Kosmos name. Consequently, for years the term caused confusion in Western circles.

There have been well over 2,000 unmanned KOSMOS missions, ranging widely in their goals. The first Soviet reconnaissance satellite successfully launched was *Kosmos 4* in 1962. Kosmos names were also assigned to trial missions and to hardware prototypes, such as *Kosmos 47 and 57,* which tested empty Voskhod capsules. *Kosmos 110* (22 February–16 March 1966), a biosatellite mission that carried two dogs, may have served as a test for both later biomissions and for Voskhod 3, which never flew. *Kosmos 434,* launched in August 1971, remained aloft for 10 years and, before it fell back to earth, was announced to have been a test for a Soviet lunar module.

Paralleling its manned space program, the Soviet Union also developed a space-based electronic intelligence network, launching the first such machine, *Kosmos 103,* in December 1965. Other functions carried out included early warning, with the first successful operational system going up as *Kosmos 903, 917,* and *931* in 1977.

The Soviet Union began using nuclear-powered satellites in the 1970s, and the general public became aware of the matter when an ocean-surveillance satellite, *Kosmos 954,* fell in Canada and dispersed its radioactive cargo.

Besides prototype spacecraft and test missions, the Kosmos designation has also been applied to Soviet shuttle development flights. Thus, on 3 June 1982 and on 15 March 1983, *Kosmos 1374* and *1443* were launched and recovered. In both cases, an Australian plane was able to photograph the recovered vehicle, which turned out to be a spaceplane, reportedly nicknamed "Kosmolyot."

The Kosmos designation remains in use, but with the fall of the Soviet Union and drastically reduced funding for Russian space activities, the term tends to apply mostly to military satellites.

Guillaume de Syon

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Kozakov, Aleksandr (1889–1919)

Leading Russian fighter ace of World War I. Aleksandr Aleksandrovich Kozakov was born on 15 January 1889 near Kherson, Russia, to a family of minor nobility. Kozakov was educated in military schools and commissioned a *kornet* (junior lieutenant) in a cavalry regiment. In early 1914, he was admitted to the flying school at Kacha. Graduating in October 1914, he was promoted to *poruchik* (lieutenant) and sent to the IV Corps Aviation Detachment, where he flew the Morane G two-seat monoplane. Since his aircraft could not carry a machine gun, in March 1915 he experimented with using a grappling hook and cable to attack enemy aircraft. In his first combat encounter the device failed, but Kozakov brought the enemy down by ramming its upper wing with his landing gear, the second ramming attack in history. He was able to land his own damaged Morane.

In September 1915, he was promoted to *stabsrotmistr* (captain) and transferred to the IXX Corp Aviation Detachment, where he was able to fly a Nieuport 10 armed with an obliquely mounted Maxim machine gun. Though this device was difficult to aim, he was finally able to shoot down an enemy aircraft on 17 June 1916, followed by several more successes. At the end of August, Kozahov commanded the 1st Battle Aviation Group, which was formed from several Russian flying detachments that were to be Russia's first specialized fighter units. The units received the Nieuport 11 and Nieuport 17 Scouts to fly. On 2 December 1916, Kozakov scored his fifth air victory, becoming an ace. Kozakov scored his seventeenth confirmed (plus three more unconfirmed) air victory on 26 November 1917.

The Bolshevik Revolution caused Kozakov to leave the military in early 1918. Strongly conservative in sentiment, when the civil war broke out he resisted the repeated attempts of the Bolsheviks to pressure him into joining the Red Army and instead rallied to the anticommunist Whites, joining the British intervention forces at Murmansk in June 1918. The British promoted him to major and appointed him commander of the Slavo-British air squadron. During July he flew numerous air support sorties in the Sopwith Snipe against the Red forces and was awarded the British Distinguished Flying Cross, in addition to the numerous czarist medals he had been awarded. However, the anticommunist movement in northern Russia was a lost cause. On 1 August 1919, just after taking off from his airfield, Kozakov stalled and crashed in what witnesses agreed appeared to be a suicide.

George M. Mellinger

See also

Imperial Russian Air Service; Taran

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Kozhedub, Ivan (1920–1991)

Soviet fighter pilot and top-scoring Allied ace of World War II. Ivan Nikitovich Kozhedub was born in the Sumy region, Ukraine, on 8 June 1920. After learning to fly in an aeroclub, he joined the army in 1940 and completed military flight school in February 1941. Kozhedub was fortunate to be retained as an instructor and missed the slaughter of the first two years of war, entering combat only in March 1943 with the 240 IAP (Fighter Air Regiment), flying the La-5. Thus, for his entire career Kozhedub was able to fly aircraft the equal of his enemies. He received his first Hero of the Soviet Union (HSU) honor for 26 victories on 4 February 1944 and his second HSU on 19 August 1944. By the end of the war, Kozhedub had flown 330 sorties and scored 62 official individual victories. He claimed that he actually shot down more than 100 enemy aircraft, but many were unconfirmed because they were destroyed deep in enemy territory; he never bothered to count his group kills. Among his victories was an Me 262, shot down in February 1945, one of six jets claimed by Soviet pilots. He was awarded his third HSU on 18 August 1945, an award equaled only Marshal Georgy Zhukov and Aleksandr Pokryshkin. There were two more unofficial victories, which Kozhedub regretted. In April 1945 over Berlin, he was attacked by four unfamiliar fighters and shot down two before noticing the white stars. One surviving Mustang pilot reported that he had been shot down by a red-nosed Fw 190, which is how he misidentified Kozhedub. From March 1951 to February 1952, Kozhedub commanded the 324 IAP in combat over North Korea, although he did not fly combat missions on Stalin's personal order. Kozhedub continued flying fighters until 1970. In 1978, he retired from active duty with the rank of marshal. He died on 8 August 1991.

George M. Mellinger

See also

Fighter Air Corps, 64th; Kursk, Battle of

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Kreipe, Werner (1905–1967)

Luftwaffe Chief of Staff with the shortest term in the office. Kreipe enlisted in an artillery regiment after World War I and joined the Nazi Party in time to take part in the 1923 Muenchen Beer Hall Putsch. He was commissioned in the Reichswehr (the interwar army), trained as a pilot, and was soon accepted into the Luftwaffe, where he quickly rose in rank while serving in a variety of staff and command positions.

He became Luftwaffe Chief of Staff after the death of Guenther Korten but argued vocally with Hitler over the employment of the Me 262 and was relieved after only four months in the position. Kreipe ended the war as a lieutenant general in command of the Air War Academy. Postwar, he became a civil servant in the West German government.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Kuban Air Battles

Major air campaign that marked the shift from German to Soviet air superiority on the Eastern Front during World War II. During April and May 1943, as the Germans struggled for their last North Caucasus foothold, Luftflotte 4 (Fourth Air Force) clashed with the Soviet 4 and 5 Air Armies, the Black Sea Fleet Aviation, and Long Range Aviation. Air activity was intense, often seeing as many as 100 air combats a day.

German forces began with about 900 aircraft, including the latest models of the Bf 109G and the Hs 129, and featured some of their top units, including Jagdgeschwader 52 with Erich Hartmann. The Soviets began with about 600 aircraft, swelling to 1,150 in May. The Soviets also committed their newest aircraft, including the first use in the south of the Douglas A-20, as well as the Bell P-39D, flown by Aleksandr Pokryshkin's air division.

The Soviets showed a new aggressiveness in flying offensive fighter sweeps, and they introduced new tactics, including German-style four-plane formations and Pokryshkin's Kuban Ladder, a stacked formation. Also playing a distinguished role was the Soviet women's night-bomber regiment. The campaign ended suddenly on 7 June, at which point the Soviets had claimed 1,100 German aircraft destroyed; the Germans claimed 2,280 victories, but the tide of the air war had turned against them.

George M. Mellinger

See also
Hartmann, Erich; Night Witches; Pokryshkin, Aleksandr

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Kursk, Battle of (1943)

Celebrated tank battle of World War II during which air operations played an important role. Both sides employed air divisions in support of the operation. As for the German Luftwaffe, 1st Division, consisting of two *luftflottes* (air forces) with a total of 2,050 aircraft, was made available. Because Operation CITADEL called for a two-prong attack against the Russian stronghold at Kursk, Army Group Center was supported by Luftflotte 6 commanded by General Ritter von Greim; Army Group South was supported by General Otto Desslach's Luftflotte 4.

On the Russian side, three air armies were made available to defend the Russian salient. The Sixteenth Air Army under Marshal S. I. Rudenko supported the Central Front, the Steppe Front was supported by Fifth Air Army under Colonel General Goryunov, and the Voronezh Front was supported by Air Marshal S. A. Krasovski's Second Air Army.

Air operations began the first day when long-range radar alerted the Germans to a preemptive attack by the Second Air Army on airfields around Kharkov. The Germans, preparing for preemptive strike of their own, were able to get all serviceable aircraft airborne. The Russian force of 450 airplanes, expecting to catch the Germans by surprise, took heavy losses when it ran into waiting German fighters, giving the Germans air superiority in that sector.

The Battle of Kursk saw Germans using aircraft to make up for losses suffered at Stalingrad and in Africa. Specialized Junkers Ju 87G Stukas and Henschel Hs 129Bs were used as flying artillery to compensate for weak ground artillery. Their formations were responsible for killing hundreds of Russian tanks. On the Russian side, Ilyushin Il-2M3 Shturmoviks armed with 37mm cannons were used with devastating effect against German armor.

In addition to the flying antitank weapons, the Germans armed their Focke-Wulf Fw 190As with SD-1 and SD-2 antipersonnel containers that rained down fragmentation bomblets on infantry and artillery positions. The Russians concentrated on antitank operations and getting as many aircraft as possible into the fighting. In the end, quantity overshadowed quality. The Luftwaffe, unlike the Russians, did not have a steady supply of replacements for men and materiel. In order to bring the 1st Division to its preinvasion strength, all other air units on the Eastern Front had to be stripped of every available aircraft.

By 9 July, with the German attack faltering on the northern prong of the offensive, 50 percent of Luftflotte 6's forces were shifted southward to support a possible breakthrough. In the end, Operation CITADEL fell short of its goals, and the offensive was suspended with the U.S. invasion of Italy. The combat initiative passed into Soviet hands and was never relinquished.

Brian B. Carpenter

See also
Ilyushin Il-2 Shturmovik; Stalingrad, Battle of

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Kutakhov, Pavel (1914–1984)

Soviet World War II fighter ace, later commander of the Red Air Force. Pavel Stepanovich Kutakhov was born on 16 August 1914 in Malokirsanovka, Russia. He completed flight school in 1938 and flew during the Russo-Finnish war in 1939–1940. He began World War II as a captain assigned to the 145 IAP (Fighter Air Regiment), later designated the 19 GIAP (Guards Fighter Air Regiment), based near Murmansk, where he spent the entire war. In May 1944, he was promoted to colonel and appointed regiment commander. For most of the war he flew the U.S. P-39 Airacobra, in which he scored all but one of his victories. By the end of the war he flew 367 sorties and fought 79 air battles, scoring 13 personal and 28 shared kills.

After the war he was one of the first Soviet officers to train in jets and later held a series of important assignments. In March 1969 he became commander in chief of Soviet air forces and deputy minister of defense. In 1972, he was promoted to chief marshal of aviation. During his tenure as commander, Kutakhov did much to modernize the Red Air Force, paying particular attention to lessons of the Vietnam War and the defeats of the Soviets' Arab allies by the Israelis. He reequipped the Red Air Force with modern aircraft, introduced new weapons systems such as laser-targeting, and sponsored improved tactics and operating procedures. It was also on his watch that the Soviets greatly expanded their MiG diplomacy, spreading modern Soviet aircraft across the world in unprecedented numbers. In 1984, he received his second honor as Hero of the Soviet Union on his birthday. He died in service on 3 December 1984.

George M. Mellinger

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L

Lafayette Escadrille/Flying Corps

Anxious not to miss the war in which their country had declared neutrality, many Americans left the United States to enlist in other nations' militaries. During 1915, a small group including Norman Prince and William Thaw, among others, began lobbying the French government for the formation of an all-American squadron. In May 1916 their efforts were realized with the formation at Luxeuil-les-Bains of Escadrille N (Nieuport) 124—the Escadrille Américaine. Original members included Prince, Thaw, Kiffin Rockwell, Elliot Cowdin, Bert Hall, James McConnell, and Victor Chapman. The unit was commanded by a French officer, Capitaine Georges Thénault.

Over several months, the novelty and political problems inherent in a squadron of volunteers from a neutral country flying over the front generated a flood of publicity and diplomatic problems between Washington and Berlin. Campaigning for reelection with an antiwar slogan ("He kept us out of war"), President Woodrow Wilson was not happy with the situation and made a request to the French for a name-change. After brief consideration of the rather colorless Escadrille des Voluntaires, Dr. Edmund Gros—an American doctor practicing in Paris who had been involved in helping form the unit and had since been its Paris representative and unofficial recruiter—suggested the name Escadrille Lafayette.

The Lafayette quickly attracted more than enough recruits to fill one unit, the overflow going to other French escadrilles, giving rise to the term "Lafayette Flying Corps" in reference to any American serving with French aviation. Ironically, the Flying Corps outlived the Escadrille, as the latter ceased to exist on 18 February 1918 when it was transferred to the U.S. Air Service as the 103d Aero Squadron, whereas members of the former continued on with the French right up to the Armistice.

Originally valued by the French as a propaganda tool, the Escadrille and Flying Corps rendered distinguished service, earning unique places in American and French aviation history.

James Streckfuss

See also

Lufbery, Gervais Raoul

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Langley, USS

First U.S. aircraft carrier. The *Langley* began its career as the USS *Jupiter,* a collier. The keel for the *Jupiter* was laid down on 18 October 1911, it was launched on 24 August 1912, and it was completed on 7 April 1913. It was the first Navy vessel to be powered by a turbo-electric system and served during World War I, most notably when *Jupiter* and the collier USS *Neptune* transported the Navy's 1st Aeronautic Detachment to France in June 1917.

Following the end of the war, as a result of the British success with the HMS *Argus,* the U.S. Navy felt a need to investigate the concept of the aircraft carrier. On 15 April 1919, the Navy Board voted to convert *Jupiter* to an experimental aircraft carrier. *Jupiter* was decommissioned at the Norfolk Navy Yard on 24 March 1920, and the conversion began under the designation CV 1. It was commissioned as a carrier on 20 March 1922, renamed after aeronautical pioneer Samuel Pierpont Langley. *Langley* displaced 13,989 tons and measured 542 feet by 65 feet; the wooden flight deck measured 523 feet by 65 feet; lift was 36 feet by 46 feet. It also had two catapults (originally), two seaplane cranes, an interior gantry crane, and stowage for 251,000 gallons of aviation fuel. The original flight-deck arresting gear was similar to that used on the *Argus,* but this was later replaced by a totally athwartship system. The *Langley* began aircraft dock trials in October 1922, and the first takeoff was made on 17 October 1922. The first catapult takeoff occurred on 18 November 1922. In December 1922, the *Langley* began to receive its first air component—Squadron VF-1.

By the mid-1930s, the experimental value of the *Langley* had come to an end, and it was decommissioned on 25 October 1936 at the Mare Island Naval Shipyard for conversion to a seaplane tender. It reemerged on 25 February 1937 with the designation AV 3. Japanese aircraft sank the *Langley* on 27 February 1942 while en route to Tjilatjap, Java, with a cargo of U.S. Army Curtiss P-40 aircraft.

Noel C. Shirley

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Laos

The U.S. involvement in Vietnam came through Laos, a sparsely populated, neutralist kingdom consisting mostly of rugged mountains, tropical jungles, and dense rain forests. From 1964 through 1972, the United States flew well over 1 million combat sorties to drop almost 3 million tons of bombs. Much of the war was secret, with the primary focus of the bombing aimed at the Ho Chi Minh Trail.

For the purposes of bombing, Laos was divided into three parts. In Operation BARREL ROLL, conventional air strikes carried out mostly by Air Force planes operating from Thailand and unconventional operations based in Laos and Thailand supported Hmoung guerrillas in their fight against North Vietnamese regulars and the indigenous communist Pathet Lao. In the South, Operation COMMANDO HUNT ranged over the STEEL TIGER and TIGER HOUND areas of the Ho Chi Minh Trail, with the latter being the focus of the bombing in areas of the trail in the border areas contiguous to South Vietnam.

Operation BARREL ROLL began on 14 December 1964 and at first consisted of only eight sorties per week. As the war escalated, USAF F-105s and F-4s poured into bases in Thailand, and the Air Force's 56th Special Operations Wing at Udorn Royal Thai Air Force Base joined the more conventional attacks with their unmarked T-28s flown by Air Force commandos, Thai mercenaries, and Laotian pilots trained by the United States. As the war developed, a special unit of U.S. forward air controllers known as Ravens and Air Force officers who lived in Laos as civilian officials with the U.S. Agency for International Development. They directed strikes, usually with great accuracy, in support of the Hmoung from Cessna 0–1 "Birddog" aircraft. Their operations were under the control of the U.S. Embassy in Vientiane and supported logistically by Headquarters Seventh/Thirteenth Air Force at Udorn.

In southern Laos, where 98 percent of the bombs fell, the air war focused on the Ho Chi Minh Trail. From February 1965, the bombing started in earnest with Operation STEEL TIGER directed at bombing troop encampments, supply depots, and truck parks. The distinction between STEEL TIGER and TIGER HOUND had to do with who controlled the targeting, with targets in the latter being chosen by Seventh Air Force in Saigon while STEEL TIGER came under the control of Thirteenth Air Force in Thailand. Operation COMMANDO HUNT subsumed both campaigns in November 1968, and distinctions between the two operating areas became academic with the ultimate authority for all air strikes in Laos remaining firmly in control of the ambassador in Vientiane.

Targets in Operation COMMANDO HUNT included roadways, pathways, and waterways as well as storage areas and staging bases. The trail's defenses, consisting of an estimated 1,200 antiaircraft guns, were also attacked by fighter-bombers using napalm and cluster bombs and, after 1969, laser-guided bombs. The centerpiece of Operation COMMANDO HUNT became the attack on truck traffic. Although Air Force estimates of the number of trucks destroyed (more than 12,000 in one six-month period in 1970) proved overly optimistic, but subsequent Vietnamese documentation has attested to the tremendous struggle involved in moving troops and supplies southward.

Air America, the CIA-run airline, added a final ingredient into what was sometimes dubbed the "Alice in Wonderland War," and the role played by Air America, along with other contract airlines, was vital in moving supplies and Laotian soldiers from one unimproved airstrip to another. Air America crews, many of whom lived with their families in Vientiane or in Udorn, a Thai provincial capital 50 miles south of the Laotian border, also provided important intelligence information based on their long experience in the theater and their intimate knowledge of the land. Air America crews flew World War II–vintage C-46 Commandos, C-47s, and newer C-123s along with Pilatus Porter aircraft capable of landing on small, unimproved dirt strips. Additionally, their unmarked gray Huey helicopters and larger Sikorsky H-34s played a key role in rescuing downed aircrews as well as moving guerrilla teams into and out of secluded landing zones.

Earl H. Tilford Jr.

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Lavochkin Aircraft

One of the most important Soviet fighter design bureaus during World War II. Semyon Alekseevich Lavochkin was born on 11 September 1900 in Smolensk. After serving with the Red Army, he studied engineering during the 1920s and worked with the Tupolev and other design and manufacturing bureaus. During the 1930s, he became involved with the development of plastic-impregnated plywood as a construction material as well as *delta-drevsiny,* a plastic-impregnated birch laminate.

In 1938, he joined with Vladimir P. Gorbunov and Mikhail I. Gudkov to found a design bureau specifically to use this material in fighter design. Their first design used an improved material—*shpon.* The I-301 had numerous problems needing correction, and before completion of the first batch the type was modified as the LaGG-3. This single-engine fighter, capable of about 310 mph, entered production at the beginning of 1941, and by the time of the German invasion 322 examples had been delivered, though few reached active units.

Unfortunately, this aircraft's modern appearance belied its inadequate performance, which quickly gave the LaGG an evil reputation. As production quality in the factories declined under the stress of war, production aircraft became even worse. Pilots grimly said its initials stood for *lakirovannyi garantirovannyi grob* (lacquered guaranteed coffin). Still, many of the leading Soviet aces scored a considerable portion of their victories flying the type, and it remained in production until 1944, with 6,528 aircraft produced.

During 1942, a shortage of the M-105 inline motor forced Lavochkin to experiment with marrying an M-82 radial motor to the LaGG's fuselage. The serendipitous result was the transformation of a relative failure into one of the greatest fighters of World War II, the La-5, with a speed of almost 400 mph. During late 1944, an even more powerful derivative, the La-7, entered service. The top-scoring Allied ace, Ivan Kozhedub, scored all his victories flying these aircraft. Production of the La-5 and La-7 eventually totaled 16,504. Further developments of the basic design were the La-9, which flew in 1946, and the La-11 of 1948. About 1,200–1,400 of each type were produced, and some were given to the Chinese and North Korean air forces. Some Soviet La-11s saw limited combat over Korea as night-fighters.

Lavochkin produced a number of jet fighters, of which only the La-15 entered production. This aircraft had better flight performance than the MiG-15, but its delicate landing gear and complicated systems made it unsuitable for wide use. During the 1950s, Lavochkin's bureau increasingly was redirected to the design of surface-to-air missiles, and after Lavochkin's death in June 1960 the design bureau was dispersed.

George M. Mellinger

See also

Fighter Air Corps, 64th; Kozhedub, Ivan

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Leahy, William D. (1875–1959)

Chairman of the Joint Chiefs of Staff throughout World War II. Leahy was born in Hampton, Iowa, on 6 May 1875 and attended the U.S. Naval Academy, graduating in 1897. He saw combat in the Spanish-American War, the Philippine Insurrection, and the Boxer Rebellion. During World War I, his vessels performed escort and patrol duties in the Caribbean and the Atlantic. Subsequent tours included command of the cruiser *St. Louis* and the battleship *New Mexico.*

In 1927, he was promoted to rear admiral. Staff assignments included chief of the bureaus of ordnance and navigation. He went on to command Battleships Battle Force and Battleships Force before assignment as Chief of Naval Operations from 1937 to 1939. Throughout these years, Leahy was one of the most influential of those naval officers who considered the battleship as the centerpiece of the U.S. fleet.

Leahy retired at the mandatory age in mid-1939 but was named governor of Puerto Rico by President Franklin Roosevelt. Two years later, Leahy was appointed ambassador to

Vichy, France, a critical diplomatic post. In mid-1942, Leahy was recalled to active duty, becoming Roosevelt's Chief of Staff.

He subsequently assumed duties as Chairman of the Joint Chiefs of Staff. In his new position, Leahy played a pivotal role in the U.S. and Allied war efforts. He helped translate policy into effective military strategy. Leahy did his best to reconcile the strategy of Germany First with a two-front naval war. Like Admiral Ernest King, the Chief of Naval Operations, Leahy himself would have preferred a greater naval effort in the Pacific, but he made the balanced approach effective nonetheless. Leahy was promoted to five-star rank in 1944.

Upon Roosevelt's death, he continued to serve President Harry Truman, but with less effectiveness. Opposed to the use of atomic weapons on both moral and practical grounds, Leahy was unable to influence the decision to drop the bomb on Japan. Following the war, he oversaw the reorganization of the military services and tendered valuable advice on Cold War strategy.

In 1949, he retired for a second time, somewhat disillusioned after presiding over massive demobilization, deep defense cuts, and ineffective geostrategic handling of the Soviet Union. He died in Bethesda, Maryland, on 20 July 1959.

Michael S. Casey

See also

Arnold, Henry H. "Hap"; Hiroshima; King, Ernest J.

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Leigh-Mallory, Trafford (1892–1944)

RAF air chief marshal. The son of a clergyman, Leigh-Mallory (known by his contemporaries as "LM") joined the infantry at the beginning of World War I but soon transferred to the Royal Flying Corps. He returned to France as a pilot and eventually commanded an observation squadron.

After the Armistice, LM held various assignments at home and in the empire, including a stint as an instructor at the Army Staff College. The outbreak of World War II found him as commander of the 12th Fighter Group during the Battle of Britain, where he became embroiled in a major controversy over air strategy with his superior, Air Chief Marshal Hugh Dowding. LM won, and Dowding was pushed into retirement.

In early 1944, LM was named commander in chief of the Allied Expeditionary Air Force for Operation OVERLORD under Supreme Allied Commander General Dwight Eisenhower. Initially, this position involved only the control of tactical aircraft—LM's background. However, Eisenhower believed more air assets were needed to ensure the success of the invasion, so he demanded, and received, control of the strategic bombers. Airmen in Britain and the United States greatly objected to this extension of LM's authority. As a consequence, the Allied commanders conspired behind his back to deny LM any real influence. He was aware of what was happening but was powerless to prevent it.

In November 1944, the air chief marshal and his wife were killed in a plane crash en route to a new command in Ceylon.

Phillip S. Meilinger

See also

Britain, Battle of; Dowding, Hugh C.T.

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LeMay, Curtis Emerson (1906–1990)

Early aviator and airpower advocate; U.S. general. Born in Columbus, Ohio, on 14 November 1906, LeMay, after graduating from high school, was unable to attain an appointment to West Point. He went on to earn a degree in civil engineering from The Ohio State University and a commission through the ROTC in 1927. Although he was an honors graduate, he became a Reserve lieutenant but was unable to attend flight school. LeMay took his case to the commander of the Ohio Air National Guard and was rapidly processed through for aviation cadets, earning his wings on 27 October 1929.

LeMay served as a pursuit pilot, then attended navigation school at Rockwell Field, California. His next assignment was with the 2d Bombardment Group, where he taught navigation and served as group navigator on the Goodwill missions to Latin America and for the interception of the Italian liner SS *Rex.*

Next came command of the 305th Bombardment Group, equipped with B-17s. He took the group to England during September 1942. As a brigadier general he commanded the 3d Bombardment Division within the Eighth Air Force in England. The division was equipped with both B-17s and B-24s. Recognizing the performance differences between the aircraft, LeMay opted for an all–B-17 division. On 17 October 1943, he led the 3d Bombardment Division on a mission to Regensburg, Germany, and recovered in North Africa. (It was on this date that the 1st Bombardment Division was held on the ground due to weather and made a late departure to bomb Schweinfurt. The 1st Bombardment Division lost 60 aircraft that day.)

Promoted to major general in March 1944, he was assigned to the China-Burma-India Theater, where he commanded the XX Bomber Command, equipped with B-29s. He moved to Guam, where he commanded the XXI Bomber Command, then the Twentieth Air Force through the end of World War II. General LeMay was in charge of all very heavy bombardment operations in the Pacific, using B-29s to strike the Japanese home islands.

After World War II, General LeMay orchestrated and participated in a series of B-29 long-range record-setting flights from the Pacific to bases within the United States.

In 1947, General LeMay became the first USAF deputy Chief of Air Staff for research and development. Next he commanded U.S. Air Forces in Europe. When the Soviets closed off the city of Berlin, General LeMay instituted the Berlin Airlift and placed Major General William H. Tunner, who had organized and directed the aerial resupply of China over the Hump (Himalayan Mountains), in charge of Operation VITTLES—the Berlin Airlift.

On 20 October 1947, LeMay was promoted to lieutenant general. He became the second commander of the recently formed Strategic Air Command (SAC). Considered the father of SAC, he took a floundering command and made it into the world's foremost air arm. General LeMay was a severe taskmaster when it came to performance of duty.

Observing the deplorable state of the command in the performance of its primary mission—strategic bombardment—General LeMay intensified training. He instituted a program in which key bomber crewmembers were cross-trained in each other's jobs. Next he established a bombing competition, wherein he pitted each bomb group against the others within SAC. He rewarded hard work by instituting the Spot Promotion Program whereby entire crews were raised one rank for superlative performance during the bombing competitions and for superior airmanship under adverse conditions.

General LeMay kept a list of his so-called select crews beneath the glass top on his desk. They were the best of the best in the command, the individuals he knew he could trust when the chips were down.

He worked hard and expected the same from everyone in his command. He also looked out for those in his command and their families. Shortly after SAC moved from Andrews AFB, Maryland, to Offutt AFB, Nebraska, he worked with members of Congress to obtain decent housing for SAC's single airmen in what was known as Wherry Housing. He sought support from the community and established the SAC Consultation Committee, composed of senior civic leaders. It was through this committee that he worked community issues and in return sought local and national support for his command.

General LeMay paved the way for aerial refueling first for SAC then for the entire USAF, followed by all U.S. forces and their allies. He moved SAC from a piston-powered force to an all-jet force through development of the B-47, B-52, and KC-135.

General LeMay considered the stewardship of nuclear weapons to be a very grave undertaking. He led by precept and example and expected the same from all of his officers and non-commissioned officers.

During his tenure at SAC be was designated Commanding General of Strategic Air Command, commander, then Commander in Chief. The latter was the result of SAC being designated a specified command reporting directly to the Joint Chiefs of Staff.

Throughout his career, Curtis E. LeMay was a visionary for airpower. He continually worked within the level of his command to develop, plan, staff, and execute innovative concepts.

In July 1957, General LeMay became vice Chief of Staff. He was elevated to USAF Chief of Staff on 1 July 1961, where he served until his retirement on 1 February 1965.

Alwyn T. Lloyd

See also

Boeing B-17 Flying Fortress; Boeing B-47 Stratojet; Boeing B-52 Stratfortress; Boeing KC-135; Consolidated B-24 Liberator

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Lend-Lease Aircraft

Lend-Lease was the U.S. aid program transferring, among other items, U.S. aircraft to Allied nations before and during World War II.

Lend-Lease was designed to assist Great Britain, which was fighting Germany and Italy. The English had run out of financial resources to buy military hardware. Lend-Lease bridged the gap between British needs and funds. By the formal end of hostilities (2 September 1945, when Japan officially surrendered aboard the USS *Missouri* in Tokyo Bay), the United States had supplied its 40 wartime Allies with more than $48 billion in goods.

By volume, the two most significant beneficiaries of Lend-Lease aircraft were Great Britain and the Soviet Union. England and its Commonwealth received more than 38,800 U.S. airplanes of 75 different types. Because Great Britain manufactured a variety of military aircraft, Lend-Lease aircraft merely augmented most of its inventories. Exceptions were the Dakota and Hudson, which filled a need for air transports and coastal reconnaissance. Great Britain, in turn, extended Lend-Lease by exporting some 2,000 Hurricanes and 1,300 Spitfires to the Soviet Union.

The Soviet Union received more than 18,000 aircraft from the combined arsenals of Great Britain (4,570) and the United States (14,018). Similar to the British, the Soviets manufactured a large number (115,596) of aircraft in multiple types. Unlike Great Britain, however, the Soviet Union had long-term lapses in warplane production due to Luftwaffe bombing and German troops. Germany's successes forced the Soviet Union to transfer approximately 100 aircraft factories eastward to, and beyond, the Ural Mountains. Although the Soviets employed heroic measures to reconstruct their aircraft industry, the move, coupled with a shortage of skilled workers, disrupted production in some cases for a year. The Reconstruction Finance Corporation opened a $100 million line of credit for Moscow. Other funds were advanced by the U.S. Treasury based upon future receipt of Soviet gold. President Franklin Roosevelt did not officially name the Soviet Union eligible for Lend-Lease until 7 November 1941.

U.S. aircraft sent to Soviet Russia followed three routes: by sea to Murmansk and Archangel, by sea and air to Iran, and by air from Alaska to Siberia. German submarines and aircraft made the northern sea route to the Soviet Union extremely hazardous; the route to Iran was safer but expensive in time and fuel. Alaska-to-Siberia proved to be the best route, but only after months of discussion between Americans and Russians and only after the United States agreed with Stalin that Russians would fly Lend-Lease planes from U.S. territory, avoiding any U.S. presence in Siberia. Regardless, more than half (7,926) of all Lend-Lease aircraft reached Soviet Russia via this route. Lend-Lease aircraft were not decisive in the Soviet victory on the Eastern Front of the European Theater, but they were significant.

James K. Libbey

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Lewandowska (Dowbór-Muśnicki), Janina (1908–1940)

Second lieutenant in the Polish air force; the only Polish woman incarcerated in the Soviet Kozelsk POW camp. She was born in Kharkiv, Ukraine, the elder of two daughters of Colonel-General Józef Dowbór-Muśnicki. Extremely independent and determined, she devoted herself entirely to a flying career. In 1937, she was sent to Lviv to take a military course in radiotelegraphy. Shortly before the outbreak of the war, she married instructor-pilot Mieczys*aw Lewandowski. After the wedding she returned home to Poznań to put her own affairs in order. Sadly, the young couple were never reunited.

After mobilization was ordered in August 1939, she was drafted for service in the 3d Regiment, stationed near Poznań at No. 3 Air Base. On 1 September, she was dispatched eastward by train with remnants of base personnel. After many adventures, was taken prisoner on 22 September.

There is no doubt, as confirmed by eyewitnesses, that Lewandowska was imprisoned at Kozelsk. However, her name is missing from the German Katyn list of exhumed identified bodies. Perhaps, in an attempt to hide her true identity (her father was especially hated by the Bolsheviks), she destroyed her documents and memorabilia prior to her death. It is also possible that she was killed in Kozelsk or elsewhere.

Kazimiera J. Cottam

See also

Polish Auxiliary Women's Air Force Service; Sosnowska-Karpik, Irena

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Leyte Gulf, Battle of (1944)

The largest naval battle of World War II—actually a series of battles—sparked by the Allied invasion of the Philippines. The campaign for the Philippines began with massive carrier air raids by Admiral W. F. Halsey's Task Force 38 on Formosa and Luzon in early October 1944. These attacks crippled land-based Japanese air forces for the upcoming battle.

The invasion of the island of Leyte began on 17 October. Allied land-based B-24 bombers supported the operation from newly opened bases at Morotai and Biak, but U.S. carrier task forces provided the primary means of air cover.

On 23 October, the remaining Japanese land-based air force, some 160 strong, attacked the U.S. carriers, sinking USS *Princeton.* In a notable single accomplishment, U.S. Navy Commander David McCampbell shot down nine Japanese aircraft within one hour. Although these Japanese attacks caused concerned, they were premature, and the heavy losses they took eliminated the last significant Japanese land-based air strength before the main battle was joined the next day.

The Imperial Japanese Navy reacted to the Leyte landings with its long-planned Operation SHO-1. Three Japanese task forces converged on the Philippines from Singapore, Borneo, and Japan. Northern Force, under Admiral Ozawa Jizaburo, was a carrier group approaching from Japan, virtually empty of aircraft and serving only as a decoy to distract the U.S. carrier force. Center Force, under Admiral Kurita Takeo, was a battleship fleet including the giant *Yamato* and *Musashi.* Southern Force, under Admiral Nishimura Shojo, consisted of cruisers and older battleships approaching from Borneo.

On 24 October, approximately 260 U.S. carrier aircraft attacked the Japanese Center Force in the Battle of the Sibuyan Sea. After 19 torpedo hits and 10 bomb hits, the massive battleship *Musashi* sank. Kurita ordered the force to turn about and withdraw. Unknown to the Americans, this course reversal was only temporary.

The Japanese Southern Force was defeated by a U.S. surface battle fleet at the Battle of Surigao Strait in the last battleship-versus-battleship action of the war during the night of 24 October. With Kurita's force withdrawing and the fighting at Surigao Strait turning in favor of the Americans, Halsey's Task Force 38 moved north to engage the Japanese carrier force. This it did in the Battle of Cape Engano, which effectively took the U.S. heavy carriers out of the rest of the coming battle.

Unobserved by the Americans, Kurita's Center Force had again reversed direction and at dawn on 25 October was entering Leyte Gulf as it steamed toward the largely unprotected U.S. transport fleet lying off Leyte. Between the transports and the Japanese surface fleet was a small group of slow escort carriers, identified as Taffy-3, under Vice Admiral Thomas L. Sprague. The Japanese opened fire on the Americans, beginning the engagement often known as the Battle off Samar. Surprised and vulnerable, these escort carriers bravely turned into the wind, toward the Japanese, and flew off their complement of Avenger bombers. These aircraft (along with aircraft of Taffy-2, farther south), inexperienced in attacks on naval targets, pressed home their attacks on the Japanese ships. They were joined by several destroyer escorts conducting torpedo attacks and aided by intermittent rain squalls and smokescreens. These forces attempted to harass and distract the Japanese as the escort carriers attempted to flee to the south. The escort carriers *Gambier Bay* and three destroyers escorts were sunk by gunfire, but the planes of Taffy-3 sank the cruisers *Chikuma* and *Chokai.*

In spite of his success, with the remaining escort carriers even more vulnerable and the U.S. transports still lying virtually defenseless to the south, Kurita had second thoughts. Worried about his vulnerability to further air attack, Kurita recalled his advanced units and again withdrew to the north, and the U.S. invasion fleet was saved. It was a vital mistake and cost the Japanese any chance of victory in the battle. Kurita's fears, however, were well-founded; the heavy cruiser *Suzuya,* light cruisers *Nashiro* and *Kinu,* and several destroyers were sunk by U.S. aircraft as they withdrew through San Bernadino Strait.

Leyte Gulf was also the first introduction of kamikaze attacks, which damaged several U.S. ships and sank the escort carrier *St. Lô.*

Leyte Gulf is significant in that it was only one of three major daylight surface naval actions during the entire Pacific War (with Java Sea and Komandorski Islands). Airpower generally prevented daylight operations of surface fleets in close proximity with the enemy. The battle is notable in that the mere threat of airpower saved the U.S. transport fleet from possible destruction, showing clearly that surface battle fleets held only a shadow of their former power.

Frank E. Watson

See also

Cape Engano, Battle of; Kamikaze Attacks; McCampbell, David S.

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Liberty Engine

The Liberty, originally named and trademarked as the USA Standardized Engine, was conceived to be a standardized engine of low risk. It was to have interchangeable parts wherever possible, incorporating the best that had already been demonstrated by U.S. and European industry.

On 29 May 1917, E. J. Hall, chief engineer of Hall-Scott, and J. G. Vincent, chief engineer of Packard, were brought together by E. A. Deeds of the Aircraft Production Board, and they assembled the conceptual design of the engine family with the help of three draftsmen, completing four layout views of the V-8 by 6 June 1917.

On 8 June, a team of 150 men started detail design with initial priority on the V-8. Within a few weeks, priority was shifted to the V-12, but the V-8 was first to run, on 3 July 1917, with the V-12 running on 13 August 1917. The L-8 first flew on 21 August 1917. The L-12 completed its first 50-hour test on 25 August, but real qualification testing was not completed until 6 February 1918. By this time the production process had started. Although directed to be a joint venture, development was conducted by Packard, which built the first 11 engines (six V-8s and five V-12s) with some fabrication assistance from the automobile companies; however, Hall-Scott played a significant, although not well-documented, role.

Production contracts were signed in August and September 1917 for 56,000 L-12s and 6,000 L-8s with six companies (Packard, Lincoln, Ford, General Motors [Cadillac and Buick], Nordyke and Marmon, and Trego). The Trego contract was canceled before production commenced. The first production engine was run in December. Since development and production were concurrent, production was slowed by a great number of changes—1,398 documented changes by 25 June 1918.

Certain government agencies chose to sue several of the producers for excess profits and other illegalities. Most cases were without merit. Packard and Lincoln received short shrift for their major contributions to the program, although Lincoln-built engines were supposed to be the most durable and reliable. Some 20,348 L-12s were built.

During World War I, the Liberty engine was installed in 3,431 de Havilland DH-4 and 107 Handley Page O-400 (U.S.-version) aircraft, as well as a number of experimental installations. After World War I, Libertys (some remained in service until 1942) were specified for a great many U.S. aircraft because of the oversupply manufactured. This discouraged aircraft-engine development for at least five years and was responsible for U.S. tardiness in readying high-powered engines for World War II.

Douglas G. Culy

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Liberty, USS

Notorious military incident in which Israeli aircraft and naval vessels attacked a U.S. ship in 1967. The *Liberty,* an electronic intelligence gathering vessel, was off the Egyptian coast on 8 June 1967 during the height of the Six Day War. In the early afternoon, Israeli Super Mystere B2s and *Ayah*-class torpedo boats attacked the *Liberty* in a series of sustained and well-orchestrated waves. Two hours later, 34 Americans were dead, with more than 170 wounded; the *Liberty* was still afloat but badly crippled. The crew acted with considerable courage in the face of the attack, and Captain William McGonagle was awarded the Medal of Honor for his personal heroism. Israel claimed the attack was an accident and that the *Liberty* was mistaken for an Egyptian vessel. The United States quickly accepted this explanation and hushed up the event. Over time, however, *Liberty* crewmembers and others raised legitimate questions—and corroborating evidence—about the attack, showing that Israel knowingly tried to sink the *Liberty* and lied about Israeli intentions and that U.S. commanders willingly accepted these lies. Motives for these duplicitous behaviors remain enshadowed in diplomatic secrecy and claims of national security, especially by Israel.

Robert S. Hopkins

See also

Ferrets; Six Day War; *Pueblo,* USS

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LINEBACKER (1972)

U.S. code name for bombing campaign in response to the North Vietnamese Easter Offensive. When the North Vietnamese launched a massive three-pronged invasion of South Vietnam in late March 1972, U.S. President Richard Nixon ordered Operation LINEBACKER, a resumption of the strategic bombing of North Vietnam, which had been discontinued since the cancellation of Operation ROLLING THUNDER.

The purpose of the operation, which lasted from 31 March to 23 October, was to halt the invasion. It had three objectives: destroy military supplies inside North Vietnam; isolate North Vietnam from outside sources of supply; and interdict the flow of supplies and troops to the battlefields of South Vietnam. The operation saw a number of technological innovations, including laser-guided bombs, electro-optical–guided bombs, and the long-range electronic navigation (LORAN) bombing system.

U.S. Air Force and Marine aircraft from bases in South Vietnam and Thailand and Navy aircraft from carriers in the South China Sea flew some 41,000 sorties over North Vietnam during the operation, dropping a total of 155,548 tons of bombs. In addition, aircraft mined North Vietnamese harbors, closing them to ocean traffic.

U.S. bombing destroyed 10 MiG bases, six major power plants, and all large oil storage facilities in North Vietnam. Some 75 aircraft were lost in this operation.

In October 1972, in response to progress in the peace negotiations then under way in Paris, LINEBACKER was scaled back and limited to the area south of the 20th Parallel. LINEBACKER achieved all of its objectives and played a major role in halting the North Vietnamese invasion.

James H. Willbanks

See also

ARC LIGHT; Boeing B-52 Stratofortress; LINEBACKER II; ROLLING THUNDER

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LINEBACKER II (1972)

Code name for the operation that came to be known as the so-called Christmas bombings—intense bombing campaign against North Vietnam in late 1972 to coerce the North Vietnamese back to the negotiating table. When North Vietnamese negotiators walked away from the Paris peace talks in December 1972, U.S. President Richard Nixon issued an ultimatum for them to return to the talks "or else." The North Vietnamese rejected Nixon's demand, and the president ordered an all-out air campaign against the Hanoi-Haiphong area to force an agreement on a cease-fire. This operation involved the concentrated use of B-52 strategic bombers supported by Air Force fighter-bombers flying from bases in Thailand and Navy fighter-bombers flying from carriers in the South China Sea.

During the intensive air campaign, 700 B-52 and 1,000 fighter-bomber sorties were flown against targets near Hanoi and Haiphong, dropping 20,000 tons of ordnance on airfields, petroleum storage facilities, warehouse complexes, and railroad marshalling yards. During the LINEBACKER II raids, the North Vietnamese fired more than 1,000 surface-to-air missiles (SAMs) at the attacking aircraft and deployed MiG fighter-interceptor squadrons. Eight MiGs were shot down, two by B-52 tailgunners. U.S. losses were 26 aircraft shot down, including 15 B-52s. Three aircraft were downed by MiGs; the rest, including the B-52s, were downed by SAMs. Nine were shot down during the first three days of the operation, causing a change in tactics that had more favorable results.

U.S. antiwar activists labeled the LINEBACKER II raids the "Christmas bombings," and the charge was made that it involved carpet-bombing—the deliberate targeting of civilian areas with widespread bombing designed to completely cover a city with bombs. However, the bombing was targeted against military targets; 1,318 died in Hanoi and 305 in Haiphong.

By 26 December, the Christmas bombing had inflicted heavy damage on all assigned targets. With its air defenses in shambles and most military targets destroyed, Hanoi was virtually defenseless, and on 26 December the North Vietnamese agreed to resume negotiations. LINEBACKER II ended on 29 December. The Paris Peace Accords were signed less than a month later on 23 January 1973.

Some airpower advocates point to LINEBACKER II as evidence that the war could have been won by airpower alone, but this argument neglects the fact that Nixon's policy aims in 1972 were much more modest compared to Lyndon Johnson's in 1965–1968.

James H. Willbanks

See also

ARC LIGHT; Boeing B-52 Stratofortress; LINEBACKER; ROLLING THUNDER

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Link Trainer

The Link Model C-3 trainer was the brain child of Edwin A. Link Jr., who began his career performing engineering work for his father's firm, the Link Piano and Organ Company in Binghampton, New York. In the early days of aviation, the most difficult aspects were bad weather and nighttime flights. In the 1920s, this meant that when pilots could not see outside their cockpits they had to depend on their instruments, or what is known as Instrument Flight Rules (IFR). Learning to do this was dangerous. For new pilots the only way to learn was by trial-and-error, and an error often resulted in a crash or even death.

In late 1927 and early 1928, Edwin Link, an avid pilot himself, began developing an IFR ground trainer in the basement of his father's piano factory. In mid-1928, he left his father's employ to spend all of his time building the Model C-3 trainer. He received his first patent for the trainer on 14 April 1929 and his final patents in 1931. Initially used as an amusement ride, the Link Trainer eventually became the first ground-based flight trainer that could generally simulate the behavior and control responses of an aircraft in flight. It consisted of a system of electrical motors and bellows that reacted to a manual stick and rudder controls that simulated the motion of flight.

Over the next five years, most Link Trainers were sold to amusement parks. Even though United States Army Air Corps officials recognized a need for the "Pilot Maker," as Link dubbed the stubby blue box, they lacked funds to purchase the trainer. In February 1934, USAAC pilots, badly lacking IFR experience, began flying airmail across the United States. Within days bad weather and nighttime flights had cost five pilots their lives.

Army officials began a search for solutions. They invited Link to visit the Newark Airport in New Jersey to demonstrate his toy. As fate would have it, on the day of the presentation the weather turned bad. The fact that Link landed his plane so easily using his instruments—skills developed using his own invention—provided Army leaders with an object lesson. USAAC officials were also impressed by the formal demonstration, and in March 1934 they bought six trainers that soon proved well worth the price.

The trainer looked like a small, box-shaped airplane, with a fuselage, wings, and a tail. It rested on a fixed platform and had the ability to take various positions, like a plane in flight. The hooded cockpit had a joystick, a rudder, flight instruments, earphones, and a microphone, with the last items used to communicate with the instructor. The Link Trainer was designed to be unstable, thus requiring the pilot to be in control throughout the exercise. Once a pilot was inside, it soon became clear who the experts and novices were. Eventually, USAAC leadership installed one or more Link Trainers at each of its principal flying fields.

The Link Trainer received its greatest use during World War II and the Korean War. The instructor could simulate various weather, air and mechanical conditions, and changes at a moment's notice. In this way the Link Trainer was as close to flying as trainees could get without actually leaving the ground. In addition, it allowed pilots to face crisis situations without risking their lives. It was even used to train pilots to bail out of stricken aircraft.

Indeed, virtually every U.S. pilot in World War II trained on the Link. During the war, Link built 6,721 C-3s for the Army and 1,045 for the Navy. During World War II and Korea, nearly 9,000 Link Trainers significantly reduced flight-training time for almost 500,000 pilots. It also cut costs. In 1945, an AT-6 training aircraft cost $10 per hour to operate, whereas the Link cost four cents per hour.

Following the success of its original Trainer, the Link Corporation went on to build many other simulators and ground trainers for air and spaceflight training. The C-3s also proved very durable; many are still displayed in several aviation museums throughout the world.

For his contribution to aviation and national defense, Edwin A. Link Jr. was inducted into the National Aviation Hall of Fame in Dayton, Ohio, in 1976. Most experts agree that Link's original Trainer pointed the way to today's sophisticated trainers and simulators that are still training pilots, cutting costs, and reducing accidents and injuries.

William Head and Diane Truluck

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Lippisch, Alexander Martin (1894–1976)

German aircraft designer of the Messerschmitt Me 163 Komet. Alexander Martin Lippisch born in Munich in 1894. Educated in Berlin and Jena before joining the German armed forces in World War I, he later designed delta-wing aircraft and was technical department chief at the German Research Institute for Soaring Flight.

In 1939, Lippisch designed the experimental DFS-194, a delta-wing craft powered by a rocket engine with only a vertical tailfin. Successfully tested at Peenemünde, 70 of the newly designated Me 163 Komets were ordered by the Luftwaffe. Lippisch oversaw production of more than 300 at Messerschmitt.

Although severely limited in range, the Komet interceptor hit speeds above 600 mph and climbed over 15,000 feet per minute. The Me 163 was the world's only operational rocket-engine fighter.

Lippisch came to the United States after the war and was employed at Collins Radio in Cedar Rapids, Iowa. There he worked on his delta wing, receiving numerous patents for wing-in-ground-effect craft. He died on 11 February 1976.

Jerry D. Snead

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Litvyak, Lidya (1921–1943)

World War II Soviet fighter ace and the most successful female fighter pilot. Lidya Vladimirovna Litvyak (known as

Lidya Litvyak was the highest-scoring Soviet woman ace, with eleven air-to-air victories. She was killed on 1 August 1943 and later posthumously awarded the honor of Hero of the Soviet Union. (Jean Cottam)

Lilya) was born in Moscow on 18 August 1921. She learned to fly prewar and worked as a flying instructor. In October 1941, she volunteered for the Women's Aviation Regiments organized by Marina Raskova, being selected for the 586 IAP (Fighter Air Regiment). In September 1942, she was one of a flight of four women pilots transferred to a male-pilot IAP. Initially greeted with skepticism, she was transferred out of several units before finding a home in the 73 GIAP (Guards Fighter Air Regiment), where she earned the respect of the other pilots. She flew 168 missions and scored 11 personal and three group victories, plus one balloon, and was herself shot down twice and wounded twice. Western reports that Captain Olga Yamshikova scored 17 victories are due entirely to mistaken translation. Litvyak was shot down on 1 August 1943, but because her death could not be confirmed she was denied the honor of Hero of the Soviet Union (HSU). After her body was found in 1989, she was awarded a posthumous HSU on 5 May 1990.

George M. Mellinger

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Locarno Conference

The October 1925 conference held in Locarno, Switzerland, that provided further structural maintenance of the postwar peace in Europe. Crucial to the so-called Locarno Pact was the guarantee of borders between Germany and its neighbors and a resolution not to attack another signatory nation without a mandate from the League of Nations. In addition, signatories pledged mutual support in the event of an unprovoked attack by a third power. So important was this pact that its three negotiators were awarded the Nobel Prize. Missing from the accords, however, were specific pledges by Germany not to attack Poland or Czechoslovakia; neither were Great Britain and France obliged to protect these states' frontiers. The 1928 Kellogg-Briand Pact reinforced the ideas of Locarno, especially the commitment of France, Britain, and the United States to renounce war as a means of resolving conflict. Ultimately, Germany felt little restraint in annexing portions of Czechoslovakia and invading Poland, contributing to the start of World War II.

See also

Versailles Treaty

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Lockheed Aircraft

Lockheed was responsible for some of the most interesting aircraft ever developed, including the Model 14 Hudson, P-38 Lightning, C-69 Constellation, P-80 Shooting Star, T-33 Training Star, F-104 Starfighter, U-2 Dragon Lady, SR-71 Blackbird, F-117 Nighthawk, C-130 Hercules, C-141 Starlifter, and C-5 Galaxy.

Founded by three brothers—Malcolm, Allan, and Victor Loughead—Lockheed can trace its history to the Alco Hydro-Aeroplane Company of 1912. Alco failed in 1913, but during 1916 Allan and Malcolm teamed up again to form the Loughead Aircraft Manufacturing Company. It failed in 1921. During 1926, Allan convinced a group of bankers to let him try again and, tired of the constant mispronunciations, changed the company's spelling to the phonetic "Lockheed." With the assistance of the visionary engineer John K. "Jack" Northrop, Allan Loughead built a solid reputation for the new Lockheed Aircraft Company and, by 1928, had 50 employees at his Burbank, California, factory.

In mid-1929, a buyout offer was presented to the Lockheed board of directors. Much to the chagrin of Allan Loug-

The interception of bomber aircraft under all weather conditions was a very difficult proposition, and the Lockheed F-94 was derived from the basic T-33 as an interim measure. (Walter J. Boyne)

head, the board accepted, and Lockheed became a subsidiary of the Detroit Aircraft Corporation. Allan Loughead left, never to return to the company he had founded.

Gerald Vultee was hired to replace Northrop, who had left to form his own firm, and construction of the Vega, Air Express, Sirius, Orion, and Altair series of aircraft continued to be profitable but proved insufficient to offset the losses of the parent corporation. On 27 October 1931, Detroit declared bankruptcy; Lockheed soldiered on for a while and finally discontinued operations on 16 June 1932.

Robert Gross bought the assets of the Lockheed subsidiary from bankruptcy, maintaining the company name. Gross hired Lloyd Stearman as general manager and set about designing a modern twin-engine all-metal monoplane transport—the Model 10 Electra.

During World War II, Lockheed built its own aircraft, including the P-38 and variants of the Model 14, and manufactured the Boeing-designed B-17 Flying Fortress under license. Between 1 July 1940 and 31 August 1945, Lockheed built 19,077 aircraft and was counted as the fifth-largest aircraft manufacturer in the United States.

After the war, Lockheed's Kelly Johnson became a legend by developing such aircraft as the U-2 and SR-71. The main production programs were not the fighters and spyplanes built in Burbank and Palmdale but featured the large military transports built in Marietta, Georgia. The Lockheed Missiles and Space subsidiary developed all of the U.S. submarine-launched ballistic missiles (Polaris, Poseidon, and Trident), as well as most of the spy satellites between 1960 and 1999. Other subsidiaries produced electronic warfare equipment, managed the processing and launching of the Space Shuttle, and supported the Department of Energy. Lockheed merged with Martin Marietta in 1995, creating the Lockheed Martin Corporation. In October 2001, Lockheed Martin was awarded the largest U.S. defense contract in history—worth some $200 billion—to manufacture the Joint Strike Fighter.

Dennis R. Jenkins

See also
Lockheed Martin Aircraft

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Lockheed F-104 Starfighter

Single-seat Mach 2 interceptor. Conceived by Kelly Johnson as a lightweight cannon-armed fighter, it saw limited use with the USAF but enjoyed success with 14 other air forces, largely in multirole all-weather variants. Officially known as Starfighter, its sleek fuselage and small wings earned it the nickname "missile with the man inside." Despite an early reputation for being dangerous to fly, its actual safety record is similar to other single-engine jet fighters.

Proposed to the USAF in November 1952, the J65-powered prototype took to the air on 4 March 1954 with Tony

LeVier at the controls. With a General Electric J79, stretched fuselage, and new air intakes, the Starfighter achieved twice the speed of sound; other improvements included boundary-layer control, combat flaps, and AIM-9 Sidewinder heat-seeking missiles. The F-104A entered operational service in January 1958 and established sensational speed, altitude, and climb records. Some F-104C fighter bombers served with Tactical Air Command in Vietnam, but changing requirements led to canceled orders and hasty transfer to Air National Guard units, those in Puerto Rico serving until 1975.

The Starfighter began a new career in October 1958 when it was selected by the Bundesluftwaffe in the nuclear-capable G (Germany) variant. Seven European countries followed, bringing F-104G production to 1,536 (including two-seaters) of the 2,578 Starfighters built. Their manufacture was then the largest international aviation program and paved the way for European collaboration.

A final F-104S variant, with a greater-thrust engine, improved radar, and semiactive AIM-7 Sparrow missiles, was designed for Italy. Manufactured by Aeritalia until 1979, these were the last Starfighters built and, twice updated, were still in front-line service as interceptors in 2001.

Gregory Alegi

See also

Italian Air Force; Italian Aircraft Development; Lockheed Aircraft

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Lockheed Hudson

The Lockheed Hudson was a direct outgrowth of the company's commercial Model 14 Electra. The Hudson was originally designed to meet a British requirement for a coastal reconnaissance bomber. An initial contract for 250 was issued, and the first of the type flew on 10 December 1938. A total of 1,338 Hudsons were purchased directly for the RAF and

The export versions of the Lockheed F-104 did very well, and none better than the F-104S, manufactured by Aeritalia. (Gregory Alegi)

RAAF before the aircraft became part of the Lend-Lease program. The latter aircraft carried the USAAF designation A-28. The USAAF procured 52 A-28s for the RAF, followed by 450 A-28As configured as troop transports. With more powerful engines, another 416 were built as A-29s for the Lend-Lease program, as were another 384 A-29As configured for troop transport. More than 20 RAF squadrons operated the Hudsons.

A number of Hudsons returned for USAAF service in the antisubmarine role. One of these A-29s was credited with the first successful attack on a German U-boat during World War II. Another 24 repossessed A-29Bs became photographic reconnaissance aircraft for the USAAF. The USAAF procured an additional 300 Hudsons as AT-18s and AT-18As for use as gunnery and navigational trainers, respectively. The U.S. Navy procured 20 Hudsons with the designation PBO-1. They were flown by VP-82 at Argentia, Newfoundland, and were responsible for the Navy's first two U-boat sinkings in World War II.

Alwyn T. Lloyd

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Lockheed Martin Aircraft

Major U.S. defense contractor. The end of the Cold War and the projected decline in military spending forced a consolidation in the U.S. aviation industry. One of the earliest mergers, perhaps one of the most natural and complementary, was that of Lockheed Martin in 1995.

The Lockheed Corporation and Martin-Marietta each counted some 60 percent of their business in the defense market. Each filled a need not met by the other in products and services, a situation that boded well for the new company, which was officially formed on 16 March 1995. The new entity was organized into four major sectors, within which there were almost 50 major operating companies. In addition, Lockheed Martin had major investments in five large subsidiary firms.

Once merged, Lockheed Martin made additional investments, acquiring important elements of the Loral Corporation. A proposed further consolidation, with Northrop Grumman Corporation, was not consummated because of antitrust concerns.

The new corporation emerged with strong product lines in the fields of aeronautics and aerospace and has become the sole major competitor to the other giant of U.S. aerospace, the Boeing Company, which acquired McDonnell Douglas in 1997. An unusual situation has resulted in the aviation industry in which the two firms are partners in some ventures (e.g., the Lockheed Martin F-22) and rivals in others (e.g., the Joint Strike Fighter.) In October 2001, Lockheed Martin bested its rival and was awarded the largest U.S. defense contract in history—worth some $200 billion—to manufacture the Joint Strike Fighter.

Walter J. Boyne

See also

Lockheed Martin F-22 Raptor

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Boyne, Walter J. *Beyond the Horizons: The Lockheed Story, 1908–1995.* New York: St. Martin's, 1998.

Lockheed Martin C-130 Hercules

A four-engine turboprop transport that has become the standard for military STOL transports. Besides its role as a troop and paratroop transport, it has been the platform for many different missions: the AC-130 Spectre gunship; EC-130 jamming aircraft; HC-130 aerial recovery aircraft; MC-130 aircraft for special operations, including airdropping and psychological warfare; DC-130 drone control aircraft; the JC-130 for the recovery of space capsules. The EC-130V is an airborne early warning and maritime surveillance aircraft. It also serves as an airborne and ground refueling aircraft.

In peacetime, C-130s provide emergency evacuation and humanitarian relief. Many of the earliest C-130s are still active today.

The first C-130 was delivered to the USAF in 1955, and production continues. More than 2,100 C-130s have been built, flown by more than 60 nations worldwide.

Henry M. Holden

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Lockheed Martin C-5 Galaxy

A four-engine transport, the largest in the U.S. Air Force inventory. It can carry 261,000 pounds of cargo for 3,500 miles or fly indefinitely with aerial refueling. The Galaxy is a

LAPES stands for Low Altitude Parachute Extraction System, shown here in combat. (U.S. Air Force)

"drive-through" airplane for both nose and tail loading. The C-5 is 243 feet long with a 223-foot wingspan.

The C-5 has three major compartments. The forward upper deck seats a crew of four: pilot, copilot, and two flight engineers. Behind the wing on the upper deck is the second compartment, with seats for 75 people. The third is the cargo compartment. The floor is 121 feet long and can hold six Greyhound transcontinental buses, seven UH-1 Huey helicopters, or 270 passengers.

Henry M. Holden

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Lockheed Martin F-117 Nighthawk

The USAF's premier stealth strike aircraft. The strange shape of the F-117 was dictated by the requirement to design an aircraft with very low radar reflectivity. When Lockheed and Northrop were asked by the Defense Advanced Research Projects Agency (DARPA) in 1974 to design a stealth demonstrator that would be invisible to radar, Lockheed was confronted with a dilemma. Its engineers had a formula that could predict the radar reflectivity of any given shape, but the computers of the era were simply not up to the task. The answer was to use a series of flat surfaces, which the computer could model, instead of continuously curving surfaces. The theory was that the flat surfaces could be angled in such a way as to reflect the microwave energy away from the radar site, thus allowing the aircraft to go undetected.

The approach worked, and Lockheed manufactured two demonstrator aircraft under the code name "Have Blue." Although both aircraft crashed during the test program, DARPA and the Air Force were sufficiently impressed to order production aircraft under the code name "Senior Trend" in 1977. Eventually, 59 aircraft were manufactured by Lockheed's famed Skunk Works. The F-117 is unable to exceed the sound barrier and relies on its advanced fly-by-wire control system to provide artificial stability.

Despite losing several aircraft during testing and train-

Looking more like a spacecraft from a Stephen Spielberg movie than a fighter, the Lockheed Martin F-117A stealth fighter revolutionized warfare. (U.S. Air Force)

ing, the F-117 program remained firmly under wraps at the test facility (Groom Lake, Nevada) and, later, at a new secret base (Tonopah, California). Finally, on 10 November 1988 the Air Force publicly announced that it was operating a stealth fighter. The first operational use of the F-117 was during Operation JUST CAUSE on 19–20 December 1989 to capture Panamanian strongman Manuel Noriega. Just over a year later, F-117s struck the first blow during Operation DESERT STORM to liberate Kuwait. The first combat loss of an F-117 was on 28 March 1999, about 30 miles northeast of Belgrade during the NATO bombing of Yugoslavia. The F-117 continues to be upgraded and is expected to serve for the foreseeable future.

Dennis R. Jenkins

See also

DESERT STORM

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Lockheed Martin F-16 Fighting Falcon

USAF fighter. Conceived as the low component of a high/low force (the McDonnell Douglas F-15 Eagle was the high component), the F-16 has gone on to be one of the most produced jet fighters in history. The YF-16 made its first flight on 4 February 1974 and won a flyoff against the Northrop YF-17 on 13 January 1975. The original program for 650 aircraft expanded to 1,388 for the U.S. Air Force alone. Foreign sales began in June 1975 when a four-nation European consortium (Belgium, Denmark, the Netherlands, and Norway) announced plans to manufacture 348 aircraft under license. Israel and Iran quickly followed, although the Iranian contract was canceled after the fall of the shah before any aircraft were completed.

The original single-seat F-16A and two-seat F-16B were followed by improved F-16C/D models in 1984. The first F-16 capable of using either Pratt and Whitney or General Electric engines was delivered in 1986, the first version capable of night attack in 1988, and a more powerful Block 50 version in 1991. The first production F-16 was delivered in 1978; the one-thousandth was delivered in 1983, the two-thousandth in early 1988, and the three-thousandth in late 1991. The worldwide F-16 fleet surpassed 1 million flight hours in 1986, 2 million in 1988, 3 million in 1990, 4 million in 1992, 5 million in 1994, and 8 million in 1998.

The F-16 program has grown into the largest multinational coproduction effort in history. Assembly lines have operated in Fort Worth, Belgium, the Netherlands, Turkey, and South Korea. Thirteen countries have participated in coproduction of the F-16, and major components of the aircraft have been produced in several other countries. Almost

One of the most important competitions of all time pitted the Lockheed Martin YF-22 against the Northrop Grumman YF-23. The YF-22 emerged the winner by a narrow margin, but the knowledge and experience Northrop Grumman gained may be seen in future unmanned combat aerial vehicles. (U.S. Air Force)

4,000 F-16s have been delivered to 19 air forces around the world. In addition, an improved variant of the F-16 is now in production in Japan as the Mitsubishi F-2 (FS-X).

Dennis R. Jenkins

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Lockheed Martin F-22 Raptor

The ultimate development of the Lockheed/Boeing/General Dynamics YF-22 Lightning II, which was one of the two contenders in the Advanced Tactical Fighter (ATF) competition that also spawned the Northrop/McDonnell Douglas YF-23. Each consortium produced two ATF prototypes powered by different propulsion systems (two Pratt and Whitney YF119 or YF120 engines). At the end of the ATF competition, the USAF selected the YF-22 airframe/YF119 power plant combination as the winner.

The F-22 is classified as an air-dominance fighter and is being optimized to supplement and then fully replace the Boeing F-15 Eagle air superiority fighter by the year 2025. The F-22, built in partnership with Boeing, is a dedicated low-observable (stealth) air vehicle that was designed for a first-look/first-shoot/first-kill combat scenario. In other words, operational F-22s will detect their opponents before they themselves are detected, launch their missiles, and destroy their adversaries before being discovered.

The Raptor is powered by two augmented 35,000-pound/thrust Pratt and Whitney F119-PW-100 turbofan engines. The engines feature a vectored thrust system for extraordinary agility and maneuverability and enable the F-22 to fly supersonically without use of afterburners.

A dedicated weapons system, the F-22 is armed with a single M-61A2 Vulcan 20mm cannon, two AIM-9 Sidewinder heat-seeking missiles, and up to six AIM-120 Slammer radar-guided missiles. These weapons are carried internally to aid the F-22's stealthy characteristics.

At this writing, the F-22 was scheduled to begin entering service with the 1st Fighter Wing at Langley AFB, Virginia, in late 2003–early 2004. It was to meet its initial operational capability in late 2005–early 2006.

Steve Pace

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Aesthetically one of the most attractive fighters of all time, the Lockheed P-38 was a star in Pacific operations, where two engines were life insurance for pilots in combat. (U.S. Air Force)

Lockheed P-38 Lightning

The first twin-engine single-pilot fighter to be mass-produced and the first with tricycle landing gear. Development began with a 1937 Air Corps specification for a high-performance fighter (360-mph top speed and a 6-minute climb to 20,000 feet). The resulting Lockheed XP-38 twin-engine twin-tail fighter first flew on 27 January 1939 but was lost due to pilot error landing after a dramatic 7-hour transcontinental flight. The YP-38 and production aircraft orders followed, entering service in late 1941. More than 10,000 were built by the end of the war, and the type saw service in every theater.

The USAAF top ace, Richard Bong, scored all of his 40 kills with a P-38. Several P-38s, operating at extreme range, jumped and shot down the plane transporting Japanese Admiral Isoroku Yamamoto in April 1943. The D model was the first to be called Lightning, a name bestowed by the British. The F model added wing racks for external arms; J and L versions were the most heavily produced; and M was a black-painted night-fighter. Some 500 unarmed F-4 and F-5 versions were used in reconnaissance and photointelligence missions. Maximum speed of most models exceeded 400 mph. Few remained in USAF service for long after the war, though some served in the air forces of other countries.

Christopher H. Sterling

See also

Bong, Richard I.; Johnson, Clarence L. "Kelly"; Lockheed Aircraft

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Lockheed P/F-80 Shooting Star

The first mass-produced U.S. jet fighter. Shortly after the British had flown the Whittle-powered Gloster Meteor, Lockheed legend Kelly Johnson, in one week, laid out the basic design for the P-80, using Britain's newly developed de Havilland Halford H-1 turbojet. Although the USAAF contract called for a prototype in 180 days, the first arrived at Muroc Dry Lake in 139 days and flew only four days later on 8 January 1944.

The USAF procured 525 P-80As. At production model No. 346, the Allison J33–17 engine was introduced, and subsequent production F-80s were powered by these engines.

The first product of Lockheed's soon-to-be-famous Skunk Works, the XP-80 is being flown here by the famous test and racing pilot Tony LeVier. (U.S. Air Force)

Because of the difficulty pilots were having adjusting to the single-seat P-80 (seen here), Lockheed developed a two-seated version and renamed it the T-33. (Walter J. Boyne)

On 19 June 1951, a P-80A bested the British Gloster Meteor IV 616-mph speed record by 7.73 mph.

Another 240 of these aircraft were procured as P-80Bs and featured an ejection seat, cockpit cooling, canopy anti-icing, underwing rocket launchers, and an improved J33–21 engine. The Air Force accepted 670 F-80Cs with increased engine thrust and improved armament.

With tricycle gear, the aircraft mounted six .50-caliber machine guns in the nose; the F-80C could also carry either two 1,000-pound bombs or 16 x 5-inch rockets externally.

Although it did not arrive in time to serve in World War II, the F-80 saw combat in the Korean War. With two 165-gallon external tanks, the F-80C's radius of action was increased from 100 miles to 225 miles (with a full rocket load). Field-developed Misawa tanks increased the radius of action to 350 miles. Although a pair of these 265-gallon tanks offered an additional hour of flight time, there were concerns about overstressing the wing tips.

In what was believed to be the first jet-to-jet dogfight, an F-80C downed a MiG-15 on 8 November 1950. Production of the F-80 had ended when the Korean War started. The strain of combat flying took its toll on the airframes—they deteriorated faster than they could be repaired. By the spring of 1952, an average of 7,500 maintenance man-hours per aircraft would have to be expended after just four months of operational flying.

The RF-80A had an extended and deepened nose to accommodate photographic equipment. A number of these aircraft were deployed to Korea, where they provided valuable service. The last of the 152 RF-80As produced was retired from service in 1957.

Alwyn T. Lloyd

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Lockheed SR-71 Blackbird

Supersonic spyplane capable of legendary performance. On 26 April 1962, Lockheed test pilot Lou Schalk took the first flight in this aircraft at the classified test facility in the desert of Groom Lake, Nevada. The aircraft was far more advanced than anything in the sky; when made public several years later, it would capture the world's fascination as few other aircraft ever have.

Three distinct variants were manufactured; surprisingly, none of them ever had an official name. Unofficially, they have all been referred to as Blackbirds and Habu—good nicknames for the fastest, highest-flying air-breathing aircraft in the world. The Lockheed model number of the first variant was A-12, but by a sort of inspired perversity it came to be called Oxcart, a code name also applied to the CIA program under which it was developed. The other two variants carried the Air Force designations YF-12 and SR-71.

The Blackbird was the first aircraft capable of sustained operations at Mach 3 (2,000 mph) and could attain altitudes in excess of 90,000 feet. The CIA's single-seat A-12 version was the first to become operational, and a total of 13 aircraft were built, including a single two-seat trainer. Due mainly to political considerations, only 29 operational missions were flown over Vietnam and Korea before the A-12 was retired in 1968. The three Air Force YF-12 interceptors were never seriously considered for production but proved very useful to both the Air Force and NASA in various test programs.

The definitive SR-71 version, code-named "Senior Crown" by the Air Force, made its first flight on 22 December 1964. The flight lasted just over an hour and attained a maximum speed of just over 1,000 mph. All 31 of the original SR-71s were delivered by the end of 1967. One additional aircraft, a trainer, was built up from parts of a YF-12A that had crashed at Edwards AFB and used the forward fuselage from the structural test article. The two-seat SR-71 was equipped with a much wider variety of cameras and sensors than the earlier A-12, including a sophisticated signals/electronic intelligence–gathering system.

The SR-71 operated for 25 years from special facilities at Beale AFB, California, Kadena AB, Okinawa, and RAF Mildenhall, England. As far as is known, SR-71s never made overflights of the Soviet Union, but they overflew almost every other troublespot in the world, providing valuable intelligence that could not be obtained from satellites of the era. The Air Force first tried to retire the aircraft in 1990, but Congress ordered its reactivation in 1995. A lack of mission and funding finally forced its permanent retirement in 1997.

Dennis R. Jenkins

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Lockheed T-33

USAF jet trainer. By 1947 it was obvious that the typical Air Force combat pilot was having difficulty adjusting to the

Introduced as the fastest, highest-flying air-breathing aircraft in the world, the Lockheed SR-71 captured the world's fascination as few other aircraft ever have. (Walter J. Boyne)

new jet fighters. Although each pilot was given extensive ground-schooling, his first flight experience in a jet was always solo—no two-seat jet fighters yet existed. In early 1947, Lockheed committed $1 million to design, manufacture, and test a two-seat variant of the P-80.

An uncompleted P-80C was taken off the production line and modified into a two-seat trainer. Tony LeVier took the first TP-80C on its maiden flight on 22 March 1948, and it was discovered that this longer aircraft performed better than its single-seat counterpart.

Two weeks later, the Air Force ordered 20 production TP-80Cs, although the designation was officially changed to T-33A on 11 June 1948. The Navy was sufficiently impressed to order 26 similar TO-2s. Eventually, Lockheed manufactured 5,691 T-33s of various models; an additional 656 were built by Canadair in Canada, and 210 were manufactured by Kawasaki in Japan. The aircraft would serve with more than two dozen air forces around the world, and some are still operating today.

Dennis R. Jenkins

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Lockheed U-2 Dragon Lady

U.S. spyplane. Clarence L. "Kelly" Johnson was a legendary aircraft designer who headed the famous Lockheed Skunk Works where the U-2 spy aircraft was manufactured. The initial contract for 20 aircraft contained the condition that the first one fly less than a year later. Johnson made that milestone and returned $2 million from the original $54

Yet another triumph of Lockheed's Skunk Works, the Lockheed U-2 was redesignated TR-1 in a later production version but retained the classic slender lines of the original. (U.S. Air Force)

million contract, one of the rare instances of a cost underrun in modern aerospace history.

The U-2 was ordered back into production twice, a rare occurrence. The second production run of a much different variant (the U-2R) occurred 10 years after the original. The third run was 12 years after the second, although this time the aircraft were virtually identical to the second batch.

Much of the U-2's history and current operations remains classified. The first operational mission was over communist Central Europe on 20 June 1956. Overflights of the Soviet Union ended on 1 May 1960, when Francis Gary Powers was shot down in a U-2C over Sverdlovsk. Later, overflights would be made of communist China and most troublespots around the world.

The aircraft continues to provide remarkable service even though its demise was predicted 30 years ago when spy satellites became the intelligence community's technology of choice. Interestingly, the Dragon Lady has long outlived its heir-apparent, the Mach 3 SR-71 Blackbird, another Kelly Johnson design. There are currently no plans to phase out the U-2 from service, and efforts to replace it with unmanned aerial vehicles are running into considerable development delays.

Dennis R. Jenkins

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Loehr, Alexander (1885–1947)

Luftwaffe general; executed after World War II for ordering mass killings in the Balkans. Loehr began his military service in 1906 in a Hungarian infantry regiment. In World War I, he was a staff officer in the Austro-Hungarian army. He joined the Austrian air force after the war, became its commander in 1936, and moved into the German Luftwaffe when Germany absorbed Austria in 1938.

He commanded Luftflotte 4 (Fourth Air Force) in the Polish, Balkan, and early Russian campaigns and was promoted to full general in May 1941. After 1942 he held ground commands in the Balkans. He was convicted of war crimes by a Yugoslavian court and was hanged in 1947.

Donald Caldwell

See also
German Air Force (Luftwaffe)
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Logistics

Broadly: matériel acquisition, transportation, maintenance, construction, and operation of facilities required to support military activity. During World War I, the fledgling U.S. aircraft industry, under the wartime control of the Bureau of Aircraft Production, was unable to develop and produce the quantity of combat aircraft necessary to equip the Army Air Service.

As a result, the Army Air Service relied primarily on French manufacturers for aircraft, engines, and spares. During the war, the Supply Section oversaw the acquisition of air materiel in Europe and operated a system of depots in France for distributing supplies and assembling aircraft. The bulk of munitions and fuel, though, was transported to the expeditionary forces from the United States by ship, an arrangement that has remained constant to the present day.

During the interwar years, the Army Air Corps established the basic logistics organizational structure that still exists. In 1926, the Army Air Corps created the Materiel Division, which managed the acquisition of aircraft, spares, and supplies and operated a series of depots in the United States and overseas that served as central supply points and as aircraft and equipment overhaul centers. Supply and maintenance organizations served down to the base, group, and even squadron level. During World War II, U.S. industry produced all air-war materiel required by the United States, as well as much of the materiel consumed by the Allies.

As part of the overall mobilization, the Army Air Forces dramatically expanded its support activities and organizations to achieve "logistics mass"—the national ability to produce and ship to the combat theaters an uninterrupted flow of equipment and supplies required for continuous combat operations. For most of World War II, Air Service Command and Air Materiel Command served as the primary logistics support organizations. Because its forces were dispersed throughout the globe, the AAF created in-theater logistics organizations and depots to provide theater support.

The Korean War marked several milestones in air logistics support. The introduction of jet aircraft shifted the focus away from supporting large numbers of simple aircraft to supporting smaller numbers of complex aircraft equipped with components that had to be shipped back to a depot for repair and reuse. The return flow of the logistics pipeline thus grew in proportion to the complexity of aircraft and equipment. For the first time, a theater logistics support organization, the Far East Air Materiel Command, maintained daily electronic communications with its primary center of support, HQ Air Materiel Command. The Air Force possessed long-range heavy transports capable of carrying substantial quantities of materiel, dramatically cutting transportation time of critical items. Soon after the Korean War ended, the USAF began using electronic computers to track supply inventories and forecast consumption, greatly reducing the amount of materiel required to be stockpiled.

During the Vietnam War, the vast U.S. industrial base, improved communications and jet transportation, allowed the USAF to support its combat forces at an unprecedented level. As had been the case in Korea, the greatest logistics problem facing the USAF was the need to build the air bases, port facilities, and ground transportation infrastructure necessary to support the air war.

Operation DESERT STORM proved to be a logistics triumph. Utilizing prepositioned materiel and air-transportable bare-base assets, spares kits, and munitions packages, combat-ready USAF air units moved into numerous Persian Gulf bases in a matter of weeks. Satellite communications and portable computers linked in-theater supply and maintenance personnel with their points of support in the United States and Europe. Operation ALLIED FORCE carried these advances one step farther with the use of fast transportation provided by commercial air transportation carriers, which helped cut to a few days the time between when a spare part was requisitioned and when it arrived at a deployed unit.

The U.S. air strikes and related actions in Afghanistan in 2001 pushed logistics to new limits.

William Head

See also
DESERT STORM

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London Naval Agreement (1930)

The 1930 agreement resulting from a conference hosted by Great Britain and attended by representatives of the United States, France, Italy, and Japan for the purpose of regulating the use of submarines for military purposes and placing a moratorium on the construction of capital ships. Meeting in London from 21 January–22 April 1930, the parties agreed to extend the limitation on aircraft carriers under the Washington Five-Power Treaty (1922). Although France and Italy refused to sign the new treaty, the United States, Great Britain, and Japan agreed to limit battleship tonnage to a 10:10:7 ratio, respectively. The term of the treaty extended to 1936, with another scheduled conference to be held in December 1935, at which time Japan withdrew from the agreement.

Cynthia Clark Northrup

See also
Washington Naval Conference

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LOOKING GLASS

Mission of Strategic Command's 7th Airborne Command Control Squadron aircraft to ensure command, control, and communications with U.S. nuclear forces even if the enemy destroys ground-based command centers. LOOKING GLASS aircraft were aloft continuously from 3 February 1961 until 24 July 1990, after which they remained on constant ground or airborne alert. Strategic Air Command controlled LOOKING GLASS until replaced by Strategic Command on 1 June 1992.

LOOKING GLASS aircraft were originally USAF EC-135s based at Offut AFB but were replaced on 1 October 1998 with Navy E-6Bs based at Tinker AFB. EC-135s and E-6Bs can determine the status of missiles in silos, launch them, or change their targets. The E-6B also carries a very low frequency system to communicate with ballistic missile submarines. LOOKING GLASS aircraft fly random patterns from their operating base and can remain aloft 72 hours with refueling. Aircrews consist of five officers, nine enlisted aircrew, plus the airborne battle staff commanded by an Air Force general or Navy admiral.

Seven operational teams from all the armed services form the airborne battle staffs. Each team has a chief, a communications officer, an airborne launch control officer, a single integrated operational plan adviser to advise the commander on war plans, an intelligence officer, and a logistics officer to find safe bases for returning bombers and tankers. Each team also has an emergency actions NCO, who knows the formats, contents, and wording of messages used to execute war plans, and a force status NCO, who tracks every strategic weapon in the inventory.

James D. Perry

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Lovett, Robert A. (1895–1986)

During World War II, served as assistant secretary of war for air and was the civilian focal point for the most powerful air force in the world. A graduate of Yale University, Lovett served in the Naval Air Service in World War I. Following the war from 1919 to 1921, he studied both law and business administration at Harvard University. He became a partner in the investment firm of Brown Brothers Harriman and Company. He also toured U.S. factories and maintained his business friendships with the leading industrialists of the time. He discovered an alarming lack of direction and coordination from Washington regarding aircraft production, which induced him to conclude that America was not up to the task that full-scale warfare might entail.

Lovett's report on his aviation ideas gained the attention of Secretary of War Henry L. Stimson, who offered him the position of special assistant for air matters and, subsequently, the office of the assistant secretary of war for air. From April 1940 until the end of World War II, Lovett was vitally concerned that nothing threaten industry's adherence to realistic aircraft production schedules. He attempted to settle labor disputes, at times intervening when the Office of Production Management and, subsequently, the War Production Board were at odds with the USAAF's contractors, subcontractors, and suppliers. Lovett tried to strengthen the management of inefficient aircraft manufacturing companies. During the war, Lovett acted as a sounding board for industry's complaints and requests. Stimson's clearer conception of Lovett's role led him to pronounce, "Whatever authority the Secretary of War has, you have."

He participated in the USAAF reorganization of March 1942, and his ideas influenced the character of the postwar United States Air Force. The manner in which Lovett and USAAF Chief General Henry H. "Hap" Arnold divided authority and responsibility established the pattern for civilian and military interactions at the top echelon of the USAAF and throughout the War Department.

Lovett so impressed Army Chief of Staff George C. Marshall that when the latter became secretary of state after the war he recruited Lovett as his undersecretary. Lovett would also become Marshall's deputy and successor when the general agreed to become secretary of defense in 1950.

George M. Watson Jr.

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Ludendorff, Erich (1865–1937)

German general during World War I and commander of Germany's air force. Aside from praising Manfred von Richthofen, whom Ludendorff thought was worth "three divisions," little direct evidence is available on his attitude toward aviation. However, his actions imply he thought it worth a great deal.

Upon America's entry into World War I, Ludendorff went to the German High Command with an argument for expanding aviation based on the new threat. Even though it would come at the expense of other essentials, Paul von Hindenberg and Ludendorff endorsed the so-called *Amerika Programme,* which doubled the pursuit force, created 17 new artillery aviation units, and increased aviation by 24,000 men.

James Streckfuss

See also

World War I Aviation

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Luetzow, Guenther (1912–1945)

Outstanding Luftwaffe fighter pilot and combat commander who was considered an upright, model officer by his peers and subordinates. Guenther "Franzl" Luetzow joined the Reichswehr (Germany's interwar army) in 1931, received his pilot training at the secret German base in the Soviet Union, and in 1934 joined the still-unacknowledged Luftwaffe. He led a fighter squadron in the Kondor Legion in Spain, was successful in the French campaign, and was promoted to command Jagdgeschwader 3 (JG 3; 3d Fighter Wing) during the Battle of Britain. He led JG 3 with great success in the early part of the Russian campaign. After air victory number 92 he became the fourth recipient of the Oak Leaves with Swords to the Knight's Cross of the Iron Cross. He was grounded in October 1941, after his 101st victory, and spent three years as a colonel in fighter command and staff positions. In January 1945, he led the so-called Fighter Pilots' Revolt, a frank denunciation of Hermann Goering and the Luftwaffe leadership, and narrowly escaped arrest. He was instead named fighter commander for northern Italy, a region that had no German fighters, but was recalled to join Galland's Jagdverband 44—the "Jet Unit of the Aces"—in March 1945. He began flying missions before he had regained his fighter pilot's touch or mastered his new aircraft, the Me 262, and failed to return from a mission in late April, probably the victim of a USAAF P-51. Luetzow's body has never been found.

Donald Caldwell

See also
German Air Force (Luftwaffe)
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Lufbery, Gervais Raoul (1885–1918)

Lafayette Escadrille ace. Raoul Lufbery came into the world just like the Lafayette Escadrille itself, the product of one American parent and one French. Raised by his mother's family, Lufbery by World War I had spent nearly half his life wandering the world doing odd jobs. The last few peacetime years he spent as mechanic for the pioneer aviator Marc Pourpe.

When war erupted they enlisted together, but Pourpe was killed in late 1914; Lufbery sought pilot training as vengeance. His original assignment was to bombers, but upon formation of the U.S. volunteer unit—N (Nieuport) 124, which became the Lafayette Escadrille—Lufbery was transferred and soon proved his worth as a fighter pilot, becoming the Lafayette's top scorer and the first American ace of aces.

When the Lafayette Escadrille transferred en masse to the U.S. Air Service, Lufbery left the unit (which had become the 103d Aero Squadron) and was assigned first to the 95th and later to the 94th Aero to mentor the new U.S. pilots. As a major with the 94th Aero, he fell or jumped from his burning aircraft on 19 May 1918 while pursuing a German two-seater.

James Streckfuss

See also
Lafayette Escadrille/Flying Corps
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Luke, Frank, Jr. (1897–1918)

The Arizona balloon-buster. Considering that official policy at the time made it difficult for one without college to enlist in the Air Service, how Frank Luke was accepted is unknown. But despite his background, which included work as a cowboy and gold miner, Luke managed to get into flight training at the new service's facility at San Diego.

Once abroad, Luke's debut was delayed by assignment as a ferry pilot, a common frustration for those anxious for combat. He finally arrived at the 27th Aero Squadron in the summer of 1918. His first patrol resulted in a claim that was confirmed but not believed by most in the squadron. As a result, Luke was shunned by most with the exception of Lieutenant Joe Wehner, another outcast. On the opening day of the Saint Mihiel Offensive, however, Luke proved his mettle by downing a German observation balloon, the first of 14 that would fall to him over a 17-day period. He made history 6 days later by becoming the first U.S. pilot to down five enemy aircraft (two balloons and three aircraft) in one patrol. Tragically, Wehner was lost on the same mission. A few days later, Luke lost another wingman, Ivan Roberts.

The night before his last outing, Luke had gone AWOL and was being considered for court-martial when he left, against orders, on his fatal patrol. During that mission, on the early evening of 29 September 1918, he downed three balloons before being hit by ground fire and forced to land behind German lines. Wounded, Luke was crawling toward a stream when he died either futilely exchanging gunfire with an approaching group of Germans or perhaps firing his gun to signal for medical help. Instead of being tried on charges, he posthumously became the first aviation Medal of Honor recipient. Luke Air Force Base in Arizona is named in his honor.

James Streckfuss

See also
Balloons; SPAD XIII
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M

MacArthur, Douglas (1880–1964)

After his experience in World War I, Douglas MacArthur felt that the next war would be one of maneuver and movement, in which air superiority would be crucial. As air superiority grew in stature and importance, MacArthur's attitude evolved from skepticism to enthusiasm.

MacArthur formed and nurtured this attitude amid the controversy surrounding General Billy Mitchell and his probomber philosophy. As Army Chief of Staff, MacArthur exhibited a marked ambiguity toward aviation. On one hand, he acknowledged publicly and privately the importance of air supremacy for national defense, and he defended airmen against infantry and artillery officers hostile to the Air Corps and ignorant of airpower's potential. He also endorsed torpedo-planes, long-range bombers, and other innovations. On the other hand, MacArthur refused to consider creation of an independent air force, a separate promotion list for Air Corps officers, and increased appropriations for the Air Corps at the expense of other branches. MacArthur as yet had little understanding of airpower or what it could achieve.

MacArthur carried this ambivalence to his command as adviser to the Philippine army. From Manila, he pleaded for more aircraft while at the same time deemphasizing the advantage airpower might give Japan should it choose to attack the Philippines. MacArthur promised to use every cent he could spare from the Philippine defense budget to augment its air defenses, but when he received B-17s to reinforce the islands, he neither expanded existing airfields nor constructed new ones. MacArthur also did little to procure sufficient spare parts for the planes or to ensure their protection against Japanese attack—a decision that proved disastrous in January 1942 when Japan destroyed his air force on the ground. Having complete faith in Corregidor and his infantry, MacArthur took few steps to incorporate aircraft into his defensive scheme.

MacArthur's attitude toward airpower began to change during World War II. Under the tutelage of General George C. Kenney, his air commander, MacArthur came to realize that air supremacy held the key to all future operations. After his Guadalcanal and New Guinea experiences, MacArthur saw the war in the Pacific as a battle of logistics; his primary goal was the attainment of air superiority. Continuous, calculated application of airpower, he believed, would permit his land and sea forces to strike in swift, massive strokes, saving time and equipment and sparing American lives.

Once committed to this course, MacArthur educated himself about aircraft and pilots, learning what airmen could and could not accomplish, the impact of weather on air operations, and the effective range of his fighters and bombers. Kenney, Hap Arnold, and other prominent airmen believed that MacArthur acquired more knowledge about and made better use of his air units than any other field commander in the war.

By 1944, every MacArthur offensive centered on airpower. Barrages by B-17 bombers, defended by fighters, preceded each thrust. Seeking islands that could support air units, MacArthur urged his engineers to construct airfields and drones as soon as possible. MacArthur's enthusiasm for airpower became so strong that he eventually came to endorse the creation of a United States Department of Air Force—a reversal of his position when Army Chief of Staff.

MacArthur's confidence in airpower did not mean, however, that he believed that it alone would win the war against Japan. He remained committed to a combined arms philosophy; Japan could be defeated only by the integrated cooperation of land, sea, and air forces. Although acknowledging the contribution of air units to the war effort in the Southwest

Pacific, MacArthur doubted that strategic bombing, which remained unreliable, would succeed in breaking Japan's will or ability to fight. Securing air superiority, however, would position the United States for a land assault against Japan—an assault that MacArthur was convinced would be necessary to end the conflict.

Hiroshima and Nagasaki proved MacArthur wrong; he reacted to this ultimate extension of airpower with a combination of awe, disgust, and resignation. Atomic weapons promised to magnify the horrors of war beyond the limits of human imagination; the reality of nuclear annihilation made future wars unthinkable.

MacArthur became Supreme Commander of Allied occupation forces in Japan and was concerned about the growing power of communism in Asia. The Air Force was to be a central component of his strategy, but MacArthur's enthusiasm for airpower had not changed his conviction that, in the event of war, a combination of arms would win the day. The dropping of the atomic bomb shook, but did not topple, this faith.

When North Korea attacked South Korea, MacArthur did not share the confidence of the U.S. public and airmen who believed that the U.S. Fifth Air Force could stop the North Korean advance without the introduction of U.S. ground troops. Convinced that air action alone could not deter a mobile force determined to reach its objective, MacArthur urged the early deployment of U.S. Army units.

As commander in chief of the United Nations forces, MacArthur made effective use of air strength, working as he had during World War II to secure air supremacy before launching offensives. When China intervened, MacArthur recommended the bombing of bridges across the Yalu River and of Chinese bases in Manchuria—recommendations that ran afoul of the limited war envisaged by the Harry Truman administration and the United Nations. He later favored bombing China itself—a position that contributed to Truman's decision to remove him from command. Once back in the United States, MacArthur renewed his demands for strategic bombing against China. During the presidential election of 1952, MacArthur even proposed that the Air Force use atomic weapons against Chinese positions along the Sino-Korean border. MacArthur's proposal betrayed no real appreciation for the political, moral, military, or environmental consequences of nuclear attack and was ignored by president-elect Dwight Eisenhower and the Joint Chiefs of Staff. Yet it reflected the extent to which MacArthur's thinking about airpower had evolved over five decades of military service.

Daniel E. Worthington

See also

Air Superiority; Arnold, Henry H. "Hap"; Atomic Bomb; Bismarck Sea, Air Battle of; Eastern Solomons, Battle of; Guadalcanal; Hiroshima; Korean War; Mitchell, William; Nagasaki; Philippines; U.S. Army Air Corps; United States Army Aviation; World War II Aviation

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Macchi Aircraft (Aermacchi)

Originally Nieuport-Macchi, established in 1913 in northwestern Italy to build French Nieuport aircraft under license. During World War I, the company produced 840 Nieuport and more than 800 Hanriot fighters. Also manufactured were 731 seaplanes, including an outstanding single-seat fighter, 240 of which served in the Italian navy.

Emerging in the 1920s as Aeronautica Macchi, the company continued to emphasize seaplanes. In 1922, Mario Castoldi joined the company. Spurred by the Schneider Trophy competition, Castoldi designed a series of sleek racing seaplanes. Although completed too late for the final contest in 1931, the Macchi Castoldi 72 set a speed record in 1934 for piston-engine seaplanes (440.7 mph) that remains unbeaten.

In 1937, Macchi developed an all-metal monoplane fighter, the MC.200 Saetta (Lightning). Deliveries to the Italian air force began in the fall of 1939. Saetta production totaled 1,151. Armed with two 12.7mm heavy machine guns, the Saetta was exceptionally sturdy and featured outstanding maneuverability, finger-light control, and superb visibility. Maximum speed—312 mph at 14,750 feet—was limited by an 870-hp Fiat radial engine. The main Italian adversary in the Mediterranean Theater, the Hawker Hurricane, was faster than the Saetta but inferior to it in turn rate and diving speed.

Macchi turned to the German Daimler-Benz 601A liquid-cooled inline engine, which was eventually manufactured under license by Alfa-Romeo. Powered by this 1,075-hp engine, the streamlined MC.202 Folgore (Thunderbolt) entered service in November 1941. The Folgore, 1,005 of which were built, became the backbone of the Italian fighter forces. Production was severely limited by growing shortages of raw materials and difficulty in securing engines. As the conflict wore on, skilled Italian workers were drafted to labor in German factories. A maximum speed of 372 mph was attained at 18,370 feet. Maneuverability was superb and handling superlative. Armament remained light, although the twin heavy machine guns were augmented by two 7.7mm weapons in the wings.

The Folgore proved clearly superior to the Hurricane and the Curtiss Kittyhawk. The Italian fighter could even turn inside the Spitfire V, which could outclimb its opponent only above 15,000 feet.

Installation of a 1,475-hp engine enabled the MC.205 Veltro (Greyhound) to achieve 399 mph at 23,620 feet. Addition of two 20mm wing-mounted cannons brought armament to an acceptable standard. Only 262 Veltros were manufactured, of which 66 were in service when hostilities ceased.

Following World War II, Aermacchi became justly famous for a series of jet trainers and light attack warplanes. Designed by Ermanno Bazzocchi, the MB.326, powered by a Rolls-Royce Viper turbojet, entered service with the Italian air force in 1962. Some 800 MB.326s have served in 11 air arms and have been license-built in Australia, Brazil, and South Africa. A substantially improved MB.339 was developed in the 1970s, 100 of which are operational with the Italian air force. MB.339s are also in service in New Zealand, Argentina, Peru, Nigeria, Ghana, Dubai, and Malaysia. Aermacchi is indeed an illustrious and adaptable enterprise in the rich history of Italian aviation.

Sherwood S. Cordier

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MacDonald, Charles H. (1915–)

U.S. Army Air Forces colonel in the Pacific Theater during World War II. Holder of two Distinguished Service Crosses, MacDonald was the highest-scoring P-38 pilot (27 kills) to survive the war. He became the sixth-highest U.S. World War II ace and the fourth-highest AAF ace.

Charles Henry MacDonald, born in DuBois, Pennsylvania, was a 1938 graduate of Louisiana State University, where he studied philosophy. After taking an interest in flying, he joined the Army Air Corps; after training was assigned to fly the Curtiss P-36 with the 20th Pursuit Group, which was transferred to Hawaii before the Japanese attack on Pearl Harbor. MacDonald, leading a mixed unit of P-36s and Curtiss P-40s launched after the attack, was returning to Wheeler Field when shaken U.S. gunners fired flak at his group.

MacDonald was kept in Hawaii until 1943, when he was sent back to the United States to take over as commander of the 340th Fighter Squadron (flying Republic P-47s) of the 348th Group that was going to the South Pacific. In October 1943, MacDonald was assigned as executive officer of the Lockheed P-38–equipped 475th Fighter Group "Satan's Angels" after three uneventful months flying patrols with the 348th Group. On 15 October 1943, MacDonald and 50 P-38s engaged a large Japanese force attacking Allied shipping in Oro Bay. MacDonald attacked seven Aichi Val dive-bombers and shot down two for his first confirmed kills. His P-38 was badly damaged by a Mitsubishi Zero, and he was forced to make a belly landing back at the field. This battle cost the Japanese 36 aircraft without any losses to the Americans.

The events of 25 October 1943 earned MacDonald the first of two Distinguished Service Crosses. After all except his flight of eight P-38s turned back, the Consolidated B-24 force they were covering during a raid on Rabaul was attacked by Zeros. MacDonald's small flight saved a great many bombers from being shot down. MacDonald received one confirmed kill to bring his total to four. November 1943 saw Lieutenant Colonel MacDonald become commander of the 475th Group, a position he would hold for 20 months. By the summer of 1944, he was a double-ace.

During that time, Charles A. Lindbergh, the first person to solo across the Atlantic, made an extended visit to the 475th. Lindbergh's trip proved valuable because he showed the pilots that by setting the rpm low and the manifold pressure high the P-38s would consume less fuel and be able to extend their range by 50 percent, a procedure the Fifth Air Force widely adopted. By July Lindbergh had flown 25 missions with MacDonald, and they had become friends. On a 28 July "milk run," Lindbergh was nearly shot down, saved only by his skill as a pilot. Three days later, MacDonald shot down a Zero about to take out Lindbergh. General Paul Wurtsmith placed MacDonald on a 30-day punitive leave for endangering the American hero.

MacDonald returned to command the 475th Group in time for the liberation of the Philippines. On 7 December 1944, flying his P-38 *Putt-Putt Maru* on four sorties to protect Allied landing craft in Ormoc Bay, MacDonald shot down three Zeros in the first three sorties.

Between 10 November 1944 and 1 January 1945, MacDonald got 13 more Japanese kills and was able to score 27 confirmed before the war ended. (MacDonald finished second in terms of total victories in the 475th; Thomas B. McGuire had 38.) MacDonald retired as a colonel in 1966. He has been described as a rare combat leader, one who was able to inspire respect and loyalty from his troops while excelling in the air.

Scott R. DiMarco

See also

Consolidated B-24 Liberator; Lockheed P-38 Lightning

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Mach, Ernst (1838–1916)

Philosopher-scientist. Ernst Mach was born in Chirlitz (today Brno in the Czech Republic) on 18 February 1838. He received a Ph.D. in physics from the University of Vienna in 1860 and taught at several universities in Austria-Hungary. In 1861, he proved the existence of the acoustical Doppler effect and suggested that it could help determine the relative speed of stars, thus ushering in the field of spectral astronomy.

His contribution to knowledge of the speed of sound carried on into the 1870s and concluded in 1886, when, having undertaken the study of fast-flying projectiles (he wondered about the apparent explosion of bullets after they left the cannon), he produced the first photograph of a projectile flying at the speed of sound. In the context of his life's work in physics, applied psychology, and philosophy, Mach's work on the speed of sound is small, yet it contributed greatly to the fields of speed photography, ballistics measurement, and aerodynamics. Mach retired from teaching in 1901 and moved to his son Luwdig's house at Vaterstetten (near Munich), where he died on 19 February 1916.

Guillaume de Syon

See also
Busemann, Adolf

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Magic

Name of U.S. project during World War II to break Japanese signal codes, specifically the so-called Purple, or diplomatic, code. The term has sometimes been applied to all attempts to break Japanese military codes and even (incorrectly) all World War II code-breaking.

The Purple code was broken in 1941 by the Army's Signal Intelligence Service, headed by William Friedman. Though revisionist history suggests that the Roosevelt administration knew (thanks to code-breaking) about the Pearl Harbor attack in advance, in fact military planners could only tell from code decrypts that Japan was about to make an aggressive move—but not what or where. Two well-known episodes where Magic code-breaking did have immediate operational impact took place early in the war. U.S. naval force commanders knew Japanese plans for the mid-1942 invasion of Midway (and Japan's hopes of luring out and destroying what remained of the U.S. fleet) thanks to the exhausting code-breaking efforts of Joseph Rochfort and his Hawaii-based Navy team. The ensuing battle, with great Japanese carrier and aircraft losses, was the turning point of the Pacific War. In April 1943, U.S. P-38 fighters, alerted by code-breaking of messages announcing his schedule and flight path, shot down the commander of the Japanese navy, Admiral Isoroku Yamamoto, as his aircraft neared a base in the Solomon Islands.

During and after both events, strong effort was made to divert Japanese suspicions regarding the sanctity of their codes. Japanese efforts against U.S. codes during the war were largely unsuccessful.

Christopher H. Sterling

See also
Signals Intelligence; Ultra

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Magnetic Anomaly Detection

Detection of submarines from the air by the changes they induce in the earth's magnetic field. When present in or passing through an area, submarines distort the marine magnetic field; sensors track submarines by pinpointing and measuring these anomalies. Magnetic anomaly detection (MAD) is one of the most prevalent nonacoustic techniques of submarine detection.

Magnetic anomaly detection had its genesis during World War I. Seeking alternatives to hydrophones, U.S. scientists in 1917 began experimenting with magnetic detectors. In 1918, scientists and engineers at the New London Experiment Station tested a magnetic device attached to a naval vessel. These initial tests proved disappointing; the detector's range was too limited, and it experienced difficulty in divorcing itself from the towing ship's magnetic signature and, consequently, in distinguishing the source of magnetic variance. Navy officials deemed magnetic detection impracticable and shelved it in favor of sonar.

World War II revived interest in magnetic anomaly detection. Aircraft needed a way to track a submerged submarine; magnetic detection offered a possible means. Advances in electromagnetism promised to eliminate the technical limitations that had hampered World War I devices, and innovations in aerodynamics made a marriage between aircraft and magnetic detectors feasible. In June 1942, the U.S. Navy established Project Sail to undertake research and airborne testing associated with magnetic anomaly detection. Utilizing magnetometers designed for mineral exploration, scientists succeeded in developing the magnetic airborne (anomaly) detector. Early air trials proved promising; by the end of 1942, 200 sets of MAD gear were in service. By 1943, most antisubmarine warfare (ASW) patrol aircraft were equipped with MAD equipment.

Scientists and Navy officials believed that magnetic anomaly detection would supplant sonar as the primary means of detecting submerged submarines. Faith in MAD proved unfounded; magnetic detectors in practice were found to have limited usefulness. Essentially a shallow-water weapon, MAD devices worked well in the Mediterranean and the Straits of Gibraltar but had trouble detecting and tracking submarines in the deeper waters of the Atlantic. Limited range proved to be an insoluble problem; MAD gears were useful only when directly above or very near their targets, making it impossible to find moving U-Boats or stationary vessels at a distance. Magnetic detectors also found it difficult to determine the exact source of anomalies in the marine magnetic field—a difficulty shared by the post–World War II generation of MAD systems. By the war's end, Navy officials had joined MAD with radar and sonobuoys; MAD became secondary to sonobuoys in this configuration, the reverse of what experts had anticipated.

Magnetic anomaly detection has received considerable attention in the decades since World War II. Funding for research and development increased during the Cold War, with advances in system range, sensitivity, and effectiveness. Modern U.S. ASW aircraft are equipped with either the AN/ASQ-81 MAD system or the more sophisticated AN/ASQ-208.

MAD has as yet to supplant sonar, and its future does not appear promising. Intrinsically short-range systems, MAD sensors remain best suited for localization and targeting. Improving the detective range of MAD systems has proven difficult. Innovations in submarine construction, including the use of nonmagnetic metals and degaussing, threaten MAD's future as a useful detection device.

Daniel E. Worthington

See also

Antisubmarine Warfare; Radar

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Malaya, Battles of (1941–1942)

As the probability of war with Japan grew in late 1941, the British moved the battleship *Prince of Wales* and battlecruiser *Repulse* to the Malayan base of Singapore to establish a significant, and hopefully deterrent, naval presence. It was intended that the capital ships be accompanied by the carrier *Indomitable,* but when Japan attacked Malaya in December, *Indomitable* was still undergoing repairs in Jamaica. Air defense of Malaya fell upon assorted RAF squadrons of Blenheim and Hudson bombers, Buffalo fighters, and obsolete Vildebeest biplane torpedo-bombers.

On 8 December, *Prince of Wales, Repulse,* and their escorts moved northward to intercept Japanese transports carrying troops to invade the eastern coast of the Malay Peninsula. RAF squadrons operating from land bases were to provide air cover, but this was poorly coordinated and ultimately failed. The Japanese 22d Naval Air Flotilla based in French Indochina found and attacked the British squadron with a force of more than 60 G3M2 Nell and G4M1 Betty bombers. *Prince of Wales* and *Repulse* took multiple bomb and torpedo hits and both sank, dealing a devastating blow to the British naval strength in the East.

The location of Allied bases was well-known; given the lack of an effective early warning system, many Allied aircraft were destroyed on the ground in a series of raids. Available RAF aircraft were no match for the advanced Japanese aircraft committed to the campaign, and Japan quickly won control of the air. Japanese forces advancing on the ground took over developed air bases in northern Malaya, such as at Alor Star, allowing Japanese air groups to base close to the front and in turn aiding further advances. Commonwealth forces were forced to move mainly at night and were quickly pushed down the peninsula.

RAF Hurricanes arrived as reinforcements in late January. These aircraft, with the remaining Buffalos, conducted defensive operations over Singapore, but attrition gradually reduced this force to insignificance. Commonwealth forces on Singapore surrendered on 15 February, ending the campaign.

The naval portion of the campaign highlights the difficulty of coordinating land-based air cover for surface fleets in World War II, as well as the futility of attempting surface naval operations in the face of enemy air superiority. The Japanese outperformed the Allies in the air in every way in Malaya and showed the high level of proficiency they possessed at this early point in the war.

Frank E. Watson

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Malta, Siege of

British possession sitting astride the routes from Gibraltar to Alexandria and from Italy to Africa. Axis and Allied leaders recognized the importance of Malta early in World War II, and the Axis launched an effort to bomb it into submission. Fortunately for the Allies, the Regia Aeronautica (Italian air force) was assigned the task; it had no notable success, even though only three obsolete Gloster Gladiators defended the island. The fighters—*Faith, Hope,* and *Charity*—resisted stoutly while the Maltese climbed to their rooftops to watch the show. In early 1941, the Luftwaffe arrived to assist the Italians, and the Maltese quickly abandoned their rooftops for air-raid shelters. Hitler diverted Luftwaffe forces to the invasion of the Soviet Union, but in December 1941 the Germans returned. Casualties on Malta mounted while supplies ran short, and by July 1942 the island was nearing capitulation. Malta became the most heavily bombed place in the world.

The British made many attempts to reinforce Malta. On one attempt the British lost nine of 14 Hurricanes due to miscalculation of the fighters' range. The U.S. aircraft carrier *Wasp* ferried Spitfires to Malta in April 1942. Forty-six of 48 arrived, but the Luftwaffe and inadequate ground support virtually eliminated them. A second effort in May delivered 61 of 63 Spitfires, and improved ground support prevented the Luftwaffe from catching them on the ground. Though Malta now had an effective air defense, supplies continued to run low.

In June 1942, a resupply convoy was forced to turn back without delivering supplies to Malta, seemingly confirming German Field Marshal A. C. Kesselring's May announcement that Malta was neutralized. However, the British made one last major effort. In July, Operation PEDESTAL came through with enough cargo to keep Malta alive, even allowing Malta to take the offensive against Axis supply lines to Africa. With the British victory at El Alamein, momentum in the Mediterranean shifted to the Allies. Despite a renewed air offensive by Kesselring, the loss of its Libyan airfields crippled the Luftwaffe's efforts. The siege of Malta was officially raised in May 1943 following the surrender of Axis forces in North Africa.

Grant Weller

See also

German Air Force (Luftwaffe); Gloster Gladiator; Kesselring, Albert; Mediterranean Theater of Operations; PEDESTAL; Regia Aeronautica (World War II); Supermarine Spitfire

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Manned Orbiting Laboratory (MOL)

An ambitious U.S. Air Force program, canceled in 1969, to construct a manned space station. A dedicated launch site at Vandenberg Air Force Base (SLC-6) was completed before the program was canceled. The station was to be orbited from Cape Canaveral or Vandenberg by a modified Titan III launch vehicle. Crews would use modified Gemini space capsules to travel to and from the station. A mockup of the MOL station was launched from Cape Canaveral during the Titan III development flights to verify the flightworthiness of the design. The capsule used during the unmanned Gemini 2 mission was refurbished to the MOL configuration and relaunched on the same flight to verify the modifications did not effect its reentry characteristics.

Although it was expected that MOL would develop into an operational system, the first few flights were intended to demonstrate various technologies necessary for the Air Force mission. Experiments planned ranged from military reconnaissance using large optical cameras and side-looking radar, to interception and inspection of satellites, to exploration of the usefulness of man in space and the testing of manned maneuvering units.

After MOL was canceled, the basic structure and reconnaissance systems developed for the station were used in the design of the Keyhole 11 spy satellites. Some of the experiments originally designed for MOL were subsequently performed by NASA astronauts on the Skylab missions.

Dennis R. Jenkins

Mannock, Edward (1887–1918)

British World War I ace. Edward "Mick" Mannock started the war in an unusual way. He had been working as a civilian in Turkey and was interned. Repatriated because of his health, Mannock returned to England.

After a stint with the Royal Engineers, Mannock transferred to aviation, becoming James McCudden's pupil. In April 1917, he went to No. 40 Squadron but was slow to score. Once begun, however, his tally sheet climbed steadily, and he developed into an outstanding fighter pilot. In February 1918, with his score at 16, he was made a flight commander on No. 74 Squadron, flying SE.5as.

In Tiger Squadron, as it later became known, Mannock's abilities as a leader won him the undying loyalty of his men. This became important following the war, when controversy developed over the identity of the British ace of aces. Mannock had claimed 61 victories during the war, but his biographer and squadronmate, Ira "Taffy" Jones, elevated that number to 73, putting him one ahead of Canadian ace Billy Bishop. Given the debate over Bishop's score, the matter is still open to question.

Mannock was in command of No. 85 Squadron when he fell to ground fire on 26 July 1918. He was posthumously awarded the Victoria Cross.

James Streckfuss

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Mao Tse-tung (1893–1976)

During the Long March (October 1934–October 1936), Mao Tse-tung's communist Chinese Red Army was assaulted by Nationalist (Kuomintang) airpower, and Mao learned that guerrilla forces needed protection from air attacks. Mao's views on airpower can be found in his numerous instructions to commanders and in the organization of the People's Liberation Army Air Force (PLAAF). After the Long March, Mao called for flight training in Xinjiang Province, where the pro-Soviet governor had a Soviet Russian air academy.

When Japan surrendered in 1945, Mao established his first air academy using captured Japanese aircraft and Japanese POWs. After founding the People's Republic of China in 1949, Mao established seven aviation schools. The Korean War was the PLAAF's first modern war and caused Mao to reflect on the importance of airpower and implement three principles of operation for the Chinese People's Volunteer Air Force, which were drafted by air force commander General Liu Yalou to reflect Mao's views: (1) Gain strength through the experience of war; (2) serve the land forces (all actions of the volunteer air force supported the victory of land forces, not vice versa); and (3) develop small encounters into large battles (use tactical air units from airfields inside Chinese territory; use opportunities to fight small engagements to gain experience; rotate air divisions for experience at the front; attain 100–150 operational aircraft; and deploy concentrated forces in air battle).

Attempts to provide forward airfields in North Korea were abandoned after repeated United Nations air attacks convinced Mao that control of the air was essential; in the Taiwan Strait Crisis of 1958, Mao called for greater attention to control of the air. After 1959, the Nationalist air force stopped bombing mainland coastal cities and began high-altitude reconnaissance over the mainland. Mao ordered interceptors and surface-to-air missile units to annihilate the enemy. Between 1959 and 1965, China shot down a total of 73 aircraft, including RB-57D, one P-2V, four U-2 reconnaissance aircraft and remotely piloted vehicles, and damaged another 173 aircraft.

Mao identified the basic tasks of the PLAAF as air defense and air support but never discussed an independent strategic air force. During the 41 years of Mao's leadership, he and the military high command rejected the strategic airpower theory of Giulio Douhet.

Hua Renjie with Richard C. DeAngelis

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Mareth Line, Battles of the (1943)

After defeat at El Alamein (October-November 1942) and Allied landings in French North Africa (November 1942) in Operation TORCH, Germany's Panzerarmee Afrika under General Erwin Rommel regrouped along the Tunisia-Libya frontier in old French fortifications called the Mareth Line.

In February 1943, Rommel attacked out of his Mareth Line positions but was soundly defeated by Allied armor and antitank forces, strongly supported by units of the Desert Air Force in the Battle of Medenine.

In March, units of Field Marshal Bernard Montgomery's Eighth Army outflanked the Mareth Line fortifications with a wide movement through the Matmata Hills in the south. This maneuver was possible in part because growing Allied air superiority hindered Axis air reconnaissance. Allied air interdiction also hampered the reaction of Axis armor to the flanking movement.

The battles at the Mareth Line saw the Desert Air Force, under Air Vice Marshal Harry Broadhurst, at the height of competence in support of ground operations. Hurricane

Mk.IID tank-busting aircraft were particularly effective in attacking German armor.

Frank E. Watson

See also

TORCH

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Marine Corps

See U.S. Marine Corps Aviation

Marinelli, Jack L. (1917–1982)

U.S. Army colonel. Born in Ottumwa, Iowa, he joined the Iowa National Guard as a private in 1935, received his commission as a second lieutenant of cavalry in the Guard in 1938, and went on active duty two years later. Following training as a liaison pilot at Fort Sill, Oklahoma, in 1942, he served as the battalion air officer of the 72d Field Artillery in Italy and later as the artillery air officer of II Corps and U.S. Fifth Army.

In late 1945, he established the ground forces' first aircraft testing capability, the Light Aviation Section of Army Ground Forces Board No. 1 at Fort Bragg, North Carolina. As director he led the team of four pilots that qualified on the Bell Model 47 helicopter and conducted the testing when it was procured as the H-13. He became an enthusiastic proponent of the future of rotary-wing aircraft and their military uses. One of the senior officers he convinced was his next-door neighbor, Major General James M. Gavin. In 1947, Marinelli became the second officer to be awarded the rating of Master Army Aviator.

When the Korean War started, Marinelli was chief of Army Aviation in the Office of Army Field Forces. He played a large role in the acquisition and training of Army aviation personnel in the hasty mobilization that followed. He was heavily involved in the procurement of new aircraft, coordinated the activation and training of the Army's first transportation helicopter companies, and, to meet the urgent need for an organic aeromedical evacuation capability in theater, supervised the accelerated activation, training, and deployment of the first helicopter detachments, forerunners of the first helicopter ambulance companies. These detachments became famous for evacuating thousands of front-line casualties and established the utility and survivability of helicopters in combat.

In 1952, he became the aviation officer at General Headquarters, Far Eastern Theater, overseeing the creation of the 1st Division Aviation Company (Provisional). In 1955, he became the chief aviation staff officer in the Office of the Deputy Chief of Staff for Logistics on the Army Staff. Three years later he became president of the Army Aviation Board, a position that he held until his retirement in 1962. While president of the board, he qualified as a Navy jet pilot and was the first U.S. officer to fly and test the NATO Light Weight Fighter, the Fiat G-91.

A noted combat pilot in fixed-wing liaison aircraft during World War II, Marinelli became an advocate of helicopters not only to perform the traditional Army aviation missions but to transport men and materiel in the combat area. He was one of the central figures in the group of field-grade officers who attempted to expand the missions of Army aviation following World War II.

Upon retiring from the Army Marinelli became vice president for research and development for Beech Aircraft, where he continued his strong influence on new aircraft.

Edgar F. Raines Jr. and Robert R. Williams

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MARKET-GARDEN (1944)

Allied code name for airborne operation to open a direct route through Holland and advance into Germany following the invasion of continental Europe. By the autumn of 1944, Allied forces had broken out of the beachhead established that June on D-Day and were making plans for a direct assault on the German homeland. British Field Marshall Bernard Montgomery had come up with a daring plan that called for an airborne assault to seize the bridges along the main north-south road through the Netherlands and open the door for a rapid ground assault by the British Second Army. The final objective was Arnhem—a 60-mile jump into German-held territory. Once across the bridge there, the British would be beyond the Rhine River, with open country between them and Berlin.

The operation called for the ground assault to be made by the British XXX Corps. In advance of the XXX Corps troops, the U.S. 101st Airborne Division was to be dropped on canal crossings between Eindhoven and Veghel, the U.S. 82d Airborne Division on the bridges over the Mass and Waal Rivers. The British 1st Airborne Division and the Polish 1st Airborne Brigade were to be dropped at Arnhem to capture the key bridges over the Rhine.

The massive airborne landings began on the morning of 17 September 1944. The two U.S. divisions largely accomplished their goals. However, the British paradrop and glider landing zones were too far from the Arnhem bridges, permitting an assault on only the northern end of the bridge. The remnants of 9th and 10th SS Panzer Divisions were refitting in the area and reacted quickly and violently. The British airborne troops soon found themselves surrounded by German troops. At the same time, XXX Corps failed to advance fast enough to link up with now beleaguered paratroopers, who held out for nine days and nights, a week longer than the plan called for. On 24 September, the order was given to withdraw.

Of more than 10,000 British troops parachuted and glider-landed at Arnhem, only 2,398 escaped across the river; some 1,400 died, and more than 6,000, half of whom were wounded, became prisoners of war.

MARKET-GARDEN was a failure because it depended on ground forces being able to attack on much too narrow a front, making it extremely vulnerable to German attacks from the flanks. The plan was overly ambitious and built around erroneous assumptions about German strength in the area. MARKET-GARDEN was a high-risk operation that in the end proved very costly for the Allied war effort and dashed hopes that the war could be finished in 1944.

James H. Willbanks

See also
Parachutes

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Marseille, Hans-Joachim (1919–1942)

The most successful Luftwaffe fighter pilot in World War II. Even the legendary fighter pilot Adolf Galland called "Jochen" Marseille "the unsurpassed virtuoso among fighter pilots." An officer candidate before the war, his poor disciplinary record delayed his commission until 1941, despite moderate success in the Battle of Britain in 1940—he shot down seven RAF aircraft but was himself shot down four times. In early 1941, he was transferred to the 1st Group of Jagdgeschwader 27 (27th Fighter Wing) in North Africa, where an understanding commander gave him full rein to develop his talents. Marseille soon began to score regularly against the RAF and became renowned in the theater for total command of his aircraft and for his unerring aim. His skill as a deflection shooter allowed him to score as often as targets presented themselves—he could dive into the middle of a defensive circle of RAF fighters and totally destroy it. He once shot down eight RAF fighters in 10 minutes, a day in which he claimed 17 victories in three combat sorties. He was promoted to captain and given command of a *staffel* (squadron), whose primary mission was to fly high cover for Marseille. On 3 September 1942, he became the fourth member of the Wehrmacht to receive the Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross from Adolf Hitler. Less than a month later he was dead. The engine of his new fighter seized while he was returning from a mission; Marseille struck its tail while bailing out and fell to the ground with an unopened parachute. His final victory total was 154 fighters and four bombers; all of his victims were from the Royal Air Force or the South African Air Force.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Marshall Islands (1943–1944)

Site of air operations in preparation for and support of Allied amphibious invasion. Using newly won bases in the Gilbert Islands, Allied land-based airpower attacked Japanese installations in the Marshalls throughout December 1943 and January 1944. Carrier planes joined on January 29 operating from six heavy, five light, and numerous escort carriers. On 30 January, U.S. forces landed on the outlying islands of Kwajalein, the main atoll in the Marshall chain, and on Kwajalein proper on 1 February (Operation FLINTLOCK). The entire atoll was secure by 7 February with far lighter casualties than suffered in the Gilberts.

Allied carrier forces withdrew for other operations against Truk before the airfield on Kwajalein reopened and a Japanese air raid from Saipan caused much damage ashore.

Glenn L. Martin was always attentive to the needs of the U.S. Navy. Here a seemingly nonchalant parachutist stands on the wing of a T3M torpedo plane. (U.S. Navy)

Over several days, carrier-based attacks, combined with planes of Seventh Air Force in the Gilberts, destroyed Japanese bases on Truk and Ponape. Operations against Enewetak in the western Marshalls began on 17 February (Operation CATCHPOLE); preinvasion air bombardment seemed particularly effective. Islands not suitable for the construction of air bases were left in Japanese hands, as were islands with airfields whose operation could be suppressed from Kwajalein and Enewetak.

As in the Gilberts previously, in the Marshalls Japanese land-based airpower was unable to react to the concentration of carrier-based air strength in the time or force necessary to affect the outcome. Allied possession of the Marshalls penetrated the outer Japanese defensive line, compromised the major Japanese air and naval base at Truk, and paved the way for the reduction of that base and the invasion of the Marianas, themselves important as bases for beginning a strategic bombing campaign against Japan.

Frank E. Watson

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Martin Aircraft

U.S. aircraft manufacturer. Glenn L. Martin taught himself to fly in 1909 at the age of 22 and set up his first aircraft company in 1912 in California. He was successful with a series of tractor-engine training types and was adept at attracting talented people to work for him, including Donald Douglas, Lawrence Bell, James S. McDonnell, Charles Day, Charles Willard, and James "Dutch" Kindelberger.

In 1917, Martin moved to Cleveland, where he built a new plant and on 17 January 1918 received a contract for a twin-engine four-place reconnaissance/bomber, the Glenn Martin Bomber. Although large orders were contemplated, only 10 were procured because of the Armistice. With two 400-hp Liberty engines, the aircraft had a top speed of 118 mph, which was far superior to the performance of either the German Gotha or the British Handley Page O/400.

The design was further developed into the MB-2 and subsequently the NBS-1, and 150 were procured. The aircraft gained fame due to its participation in the battleship-bombing trials led by Brigadier General William Mitchell.

Martin next developed a long line of aircraft for the U.S. Navy, including torpedo-planes, dive-bombers, and flying-boat patrollers. All of these were of conventional structure, but in 1932 the prototype of the revolutionary Martin B-10 bomber was rolled out. This twin-engine, all-metal cantilever monoplane had advanced features such as retractable gear, enclosed cockpits, and, later, the Norden bombsight. The B-10 became the most important bomber in the Army Air Corps, solidifying the concept of precision bombing and training most of the USAAF leaders of World War II.

Fame, if not financial success, was achieved with the beautiful Martin M-130 series of four-engine flying boats, led by the immortal China Clipper. Used by Pan American Airways, the Clippers established the first transpacific passenger service in 1935.

World War II saw Martin field a series of twin-engine bombers, including the Maryland, the Baltimore, and the Marauder. The latter initially had a bad reputation, but when modified and with proper training for pilots, it proved to be a highly capable combat aircraft, with the lowest loss record in Europe. Some 5,266 Marauders were built. During World War II, they flew 129,943 sorties, dropping 169,382 tons of bombs, but only 911 aircraft were lost in combat.

The firm also produced twin-engine PBM Mariner patrol planes that had a distinctive gull wing and twin vertical stabilizers. All of the Martin aircraft acquitted themselves well in combat. Martin also built 536 examples of the Boeing B-29 Superfortress.

The largest Martin piston-engine aircraft, the JRM-2 Mars, was produced in small numbers, but two are still in service as water-bombers fighting forest fires.

In the postwar years, Martin was less successful with its commercial airline and Navy designs. The 202 airliner had inherent design flaws that cut its career short, and the 404, though an excellent aircraft, failed to make money, with only 103 being produced. For the Navy, Martin built 152 AM Maulers, which resembled the Douglas AD Skyraider, and 21 four-engine P-4M Mercators, which resembled the Lockheed Neptune. Martin had greater success with the P-5M Marlin flying boat, of which 287 were built.

As he grew older, Glenn Martin became less politically adept and managed to alienate the Navy as well as the new U.S. Air Force. Two excellent designs, the P-6M Seamaster, a six-jet flying boat, and the XB-51, a three-jet attack aircraft, were not produced. The Seamaster fell victim to two accidents and the Navy's need to finance the Polaris program; the XB-51, despite its performance, did not find a role in the USAF. Instead, Martin was commissioned to build the English Electric Canberra as the B-57. It proved to be a long-lived, capable aircraft; 403 were built.

Martin then turned to the missile business and completed two major corporate mergers, becoming Martin Marietta and then Lockheed Martin. In October 2001, Lockheed Martin was awarded the largest U.S. defense contract in history—worth some $200 billion—to build the Joint Strike Fighter.

Albert Atkins

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Martin B-10/B-12 Bomber

In the early 1930s, officials in the U.S. Army Air Corps contracted with the Glenn L. Martin Company of Baltimore to build a series of twin-engine, all-metal bombers with retractable landing gear. The resulting B-10/B-12 became the first modern bombers in the USAAC operational inventory. Faster than any fighters, they helped develop theories of unescorted precision daylight strategic bombing then germinating among U.S. airmen.

The prototype Model 123 first flew on 16 February 1932. Designated the XB-907, it reached speeds of 197 mph during July trials at Wright Field, Ohio. That fall it was returned to Martin for minor upgrades.

Following successful trials in October, the Army purchased the bomber on 17 January 1933 and designated it the XB-10. Army officials also ordered 48 production aircraft. The first 14 were YB-10s and had 675-hp Wright R-1820-25 engines. The YB-10s had transparent sliding canopies over the pilot's cockpit and over the rear gunner's position.

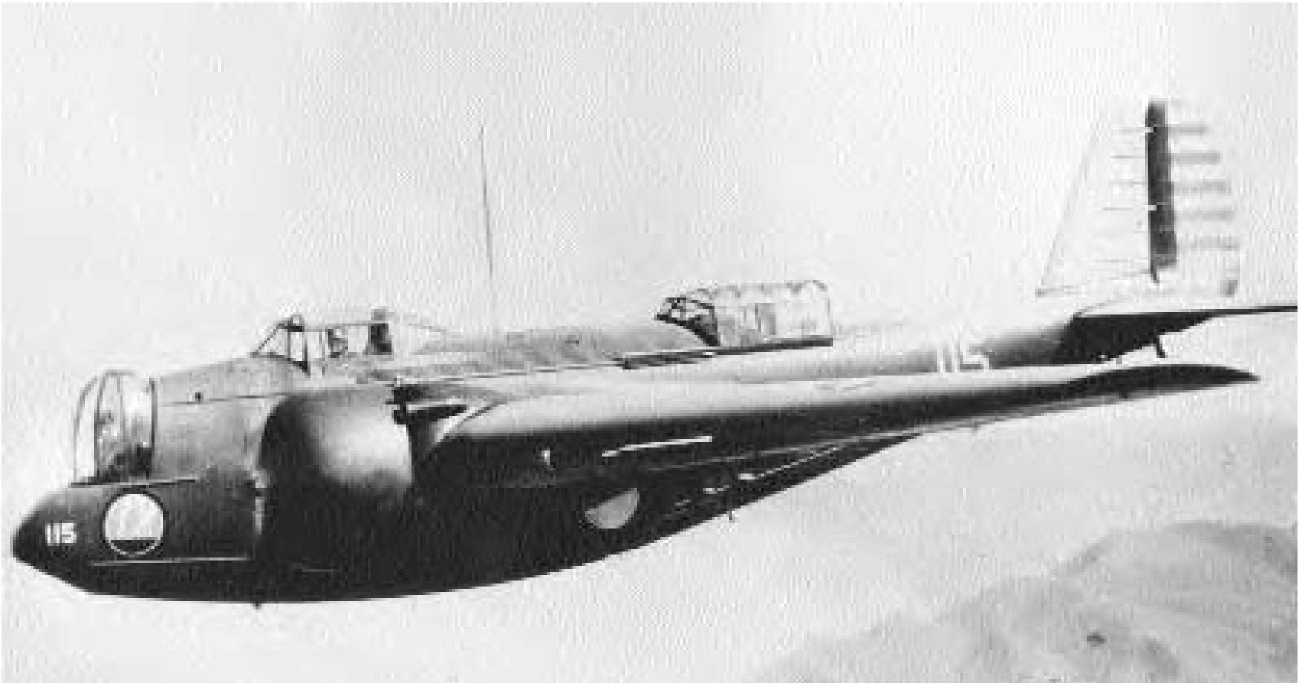
Martin completed delivery of 103 aircraft in August 1936. The B-10B had two Wright R-1820-33 775-hp engines. With a 71-foot wingspan and 45-foot length, it stood 15 feet high. Its gross weight was 16,400 pounds with a service ceiling of 24,200 feet and a range of 1,240 miles. Top speed was 213 mph, and it carried a bombload of 2,260 pounds.

The B-10/B-12s were popular among USAAC crews and a great success for Martin. In late 1932, Glenn L. Martin won the 1932 Collier Trophy for building the B-10.

The B-12As were powered by Pratt and Whitney R-1690-11 Hornet radial engines. The B-12, with its greater fuel capacity and ability to be fitted with large twin floats, took on the role of coastal defense.

In the late 1930s, the B-10/B-12s were generally replaced by Douglas B-18 Bolos and more modern four-engine Boeing B-17s. Although no USAAC B-10/B-12 ever saw combat, they did experience operational and public relations successes, such as Lieutenant Colonel Hap Arnold's B-10 Alaska survey mission of July 1934. They also set several aviation records for speed and range.

In August 1936, versions of the B-10 were demonstrated for foreign sale. Argentina bought 39 in 1936 and China bought six in 1937. Two of the Chinese planes made a



The designers at the Glenn L. Martin Company were initially slow to react to suggestions for a new bomber from Wright Field, but they eventually triumphed with the classic Martin B-10. (U.S. Air Force)

"leaflet" raid on Japan before all six were destroyed during the Japanese invasion in August 1937. The Soviet Union bought one, Siam (Thailand) bought six, and Turkey in 1937. Between September 1936 and May 1939, the Dutch bought 117 of the most modern versions for use in the East Indies. These saw combat against invading Japanese in the early 1940s.

Between 1933 and 1939, 189 export and 153 USAAC B-10/B-12/B-14s were produced and delivered. The only remaining B-10 was donated by the Argentine government to the U.S. government for display in the U.S. Air Force Museum in 1970. An export version, it was refurbished as a USAAC B-10B. It went on display in 1976.

William Head

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Martin B-26 Marauder

U.S. bomber. In 1939, U.S. Army Air Corps officials ordered the B-26 Marauder medium bomber based on design alone. No prototypes were built prior to production. Martin's Baltimore plant built 201 of this original design. The first aircraft flew on 25 November 1940, and the 22d Bomb Group in Langley, Virginia, received the first four Marauders in February 1941.

The original B-26 was powered by two Pratt and Whitney R-2800 radial engines that generated 1,850 horsepower. It had a wingspan of 65 feet, a fuselage 56 feet long, 32,000-pound maximum weight, and a crew of seven. It had a maximum speed of 315 mph and a range of 1,000 miles with a maximum bombload of 3,000 pounds.

The Marauder had a troubled developmental history, due in part to a lack of pilot familiarity and unique features such as its small wing area. Although later models eventually overcame these minor design flaws and had a stellar career, early pilots called the B-26, among other derogatory things, the "Widowmaker."

Eventually, Martin produced 12 additional models, including the CB-26B cargo version and the TB-26B, TB-26C, and TB-26G trainers. The A model was essentially a minor revision of the B-26. The major change saw 109 of the 139 A models fitted with R-2800-39 radial engines and designated B-26A-1. Fifty-two A models were sold to the Royal Air Force.

The B models were originally purchased in four blocks, each having various and unique modifications, including armament upgrades, nose-gear improvements, and larger carburetor intakes. Later, 1,242 additional B models were also produced, adding among other things better forward armaments, longer wings (71 feet), and new R-2800-43 engines.

The B-26Cs were B-26Bs built in Martin's new Omaha, Nebraska, plant. The first B-26C Block 5 rolled out in August 1942 followed by 1,210 C models and 300 AT-26B trainers. The RAF received 123 C models. An additional 615 C models on contract when the war ended were canceled.

The F model was a modification of 300 B-26B-55-MAs that improved wing performance during takeoff. The RAF received 200 F models. The last production model was the B-26G. Martin built 1,100, including 57 TB-26G trainers for the USAAF and 150 for the RAF. This model was the same as the F model with minor internal changes. One XB-26H was built to test tandem landing gears. It was the last of 5,157 Marauders built by Martin by March 1945.

Although not as famous as its B-25 cousin, the B-26 served with distinction in every major theater of World War II as a first-rate medium attack bomber. During World War II, B-26s flew 129,943 sorties, dropped 169,382 tons of bombs, and downed 402 enemy aircraft; 911 B-26s were lost.

William Head

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Martin-Baker Aircraft

British aircraft firm established by James Martin in 1929 as Martin's Aircraft Works; in 1934, Valentine Baker joined the firm to create Martin-Baker Aircraft. The MB.1 was a two-seat cabin monoplane that flew in March 1935 but had no sales and was destroyed in 1938.

The MB.2 was a single-seat fighter designed for the British F.5/34 specification, powered by a Napier Dagger rated at 1,020 shp. It used tubular construction like the MB.1 and had fixed spatted landing gear. It mounted eight machine guns in the wings and had a top speed of 320 mph. Although the MB.2 had excellent maintainability and performance, no sales were obtained.

Three prototypes of the single-seat MB.3 started design in June 1939 to fighter specification F.18/39, featuring a six-cannon wing. The Rolls-Royce Griffon engine had been selected but was not made available, and Martin had to redesign the MB.3 for the Napier Sabre of 2,020 shp. Structure was bolted tubing and stressed skin, and steel was used in the fuselage structure, with spar/rib structure of duralumin in the wing. It flew on 31 August 1942; after that flight, a cut-down rear fuselage and bubble canopy were installed. It crashed on 12 September 1942, killing Valentine Baker.

The fuselage of the second prototype was significantly redesigned for the Griffon II engine of 2,305 shp with a contrarotating propeller. It used concepts from the P-51D Mustang but kept the same basic structure as the first prototype, with the same excellent maintainability. It flew on 23 May 1944 and, after an increase in fin, rudder, and stabilizer size, was considered by all that flew it to be the best-performing fighter aircraft in their experience. Flight testing continued into 1947, but none was procured.

Martin-Baker had sustained itself by taking contracts for miscellaneous aircraft equipment, and although it built no additional aircraft, it developed a line of ejection seats that gained a strong worldwide market.

Douglas G. Culy

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Martini, Wolfgang (1891–1963)

Luftwaffe general; carries the unique distinction of holding a single position for the entire history of the Luftwaffe. Martini joined the German army as a telegraph officer in 1910 and was involved in communications for all of his 35 years of military service and an 18-year postwar career. He joined the still-secret Luftwaffe in 1933, became chief of its Signals Office in 1934, and retained that post until V-E Day. He reached his final rank of lieutenant general in 1941. He can fairly be judged to have been successful at his job. The Luftwaffe began and ended the war with the best radio navigation aids in the world and held its own in the radar wars with RAF Bomber Command despite a lack of resources and the well-documented fragmentation of its research efforts in all technical fields.

After the war, Martini played an important role in the reconstruction of West Germany's aviation and shipping industries, for which he was awarded the Great Service Cross in 1959 by the German government. He remained active in the German Society for Location and Navigation until his death in 1963.

Donald Caldwell

See also

German Air Force (Luftwaffe); Radar and How It Works

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Massive Retaliation

The concept of retaliating with nuclear weapons at a time and place of U.S. choosing in response to Soviet aggression during the Cold War. The prospect of such an asymmetrical response would, it was hoped, deter communist expansion around the globe without having to meet each individual threat via conventional means. Though the emphasis in public was on deterrence and retaliation, in private U.S. military officials also hoped that, should a war occur, the United States would be able to strike the Soviet Union so hard that a Soviet nuclear response could be severely curtailed or even prevented altogether.

The phrase *massive retaliation* was popularized during the furor in the press that followed a January 1954 address by Secretary of State John Foster Dulles to the Council on Foreign Relations. In his speech Dulles argued that "the way to deter aggression is for the free community to be willing and able to respond vigorously at places and with means of its own choosing," which would allow "our military establishment to fit what is *our* policy, instead of having to try to be ready to meet the enemy's many choices." This would therefore provide "more basic security at less cost," or what would later be called "more bang for the buck." Though Dulles's own thinking had actually become far less bellicose in recent months, one statement—that to accomplish all this the United States would have to "depend primarily upon a great capacity to retaliate instantly"—was interpreted by many to mean that the United States might use nuclear weapons in response to even a relatively minor provocation. In April, Dulles tried to clarify his message, and the Eisenhower administration's "New Look" at defense policy in general, in an article in the journal *Foreign Affairs.* In it he emphasized the importance of massive retaliation in deterring a general war with the Soviet Union and stated that while the threat should also prove useful in deterring localized aggression, in such cases the use of nuclear weapons would not be automatic. The article, however, received far less attention than the original speech had, and the phrase *massive retaliation* continued to connote to many a dangerous overreliance on nuclear weapons.

As the overwhelming U.S. strategic nuclear advantage of the early 1950s gradually withered away, criticism of massive retaliation within the policymaking elite grew. Though the nuclear playing field was still by no means level, as the Soviet capability to inflict massive damage on the United States grew, the threat that the United States would initiate nuclear war to prevent aggression on the periphery seemed more and more hollow. Crises such as those in the Taiwan Strait (1954–1955, 1958) seemed to confirm that U.S. nuclear brinkmanship might ultimately prove ineffective, reckless, or both. President Dwight D. Eisenhower reluctantly began moving toward larger conventional forces during his second term, and once John F. Kennedy assumed the presidency in 1961 the public emphasis on massive retaliation was over. Its role in deterring localized aggression was replaced by Kennedy's determination to "support any friend" and "oppose any foe," to be implemented by its new policy of flexible response. Massive retaliation's seat at the ideological core of nuclear deterrence was ultimately filled by the emerging concept of mutual assured destruction.

David Rezelman

See also

Atomic Bomb; Cold War; Missiles, Intercontinental Ballistic; Mutual Assured Destruction; Strategic Air Command

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Mayaguez Incident

The last significant United States action of the long conflict in Southeast Asia. On 12 May 1975, elements of the Cambodian navy seized an American merchant ship, SS *Mayaguez,* in international waters off Cambodia's coast. Upon notification, U.S. President Gerald Ford insisted that this not become another *Pueblo* Incident—the international crisis that developed when North Korea seized the SS *Pueblo* in 1968.

As there were no significant U.S. military forces or warships in the area, the president ordered the carrier *Coral Sea* and destroyers *Holt* and *Wilson* to steam at full speed to the Gulf of Thailand. Meanwhile, U.S. Air Force and Navy planes from the Philippines took off to find the *Mayaguez.* The ship was sighted by the crew of a P-3. It was anchored off Koh Tang Island, 40 miles from the Cambodian shore.

An Air Force task force of HH-53 and CH-53 helicopters of the 40th Aerospace Rescue and Recovery Squadron and the 21st Special Operations Squadron was dispatched to U Tapao Air Base in Thailand, from Nakhon Phanom Air Base in the northern part of the country. The helicopters carried a large contingent of security policemen. En route, one of the helicopters crashed, killing all 23 men onboard.

Additionally, a battalion-sized Marine landing team was airlifted from Okinawa to U Tapao. As it arrived, the destroyer *Holt* was directed to seize the *Mayaguez* while the Marine force, airlifted and supported by the Air Force, was to rescue the crew, at least some of whom were believed to be held on Koh Tang.

On the morning of 15 May, 175 Marines were flown by helicopters from U Tapao to Koh Tang. They were met by a force of approximately 200 heavily armed Khmer Rouge troops, who shot down three of the first eight helicopters and damaged two others. About 100 Marines were put ashore. In immediate and constant contact with the enemy troops, they were supported by Air Force forward air controllers in OV-10s and air strikes from A-7s, F-4s, and AC-130s.

Strike aircraft from the *Coral Sea* hit targets on the Cambodian mainland. Subsequently, a fishing boat was seen approaching the destroyer *Wilson* with white flags flying. Aboard were the 39 crewmen of the *Mayaguez.*

With the safe return of the *Mayaguez* crew, the Marines on Koh Tang were ordered to disengage and withdraw. However, the Khmer Rouge troops continued to attack the Marine force. The battle raged throughout the day, and the last of the Marines were not evacuated until after dark. Inadvertently, four Marines and a Navy medic were left behind. They were taken prisoner by the Khmer Rouge and executed.

Four CH-53 and HH-53 crewmen (First Lieutenant Donald R. Backlund, First Lieutenant Richard C. Brim, Staff Sergeant John D. Harston, and Captain Rowland W. Purser) were awarded the Air Force Cross for their actions that day, the last awarded in that long and tragic war. One of the Americans killed in the action at Koh Tang Island, Second Lieutenant Richard Vandergeer, a copilot on one of the lost helicopters, is the last name etched onto the wall of the Vietnam War Memorial in Washington, D.C.

Darrel Whitcomb

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McCain, John S. (1884–1945)

U.S. Navy admiral. Born on 19 August 1884 in Teoc, Mississippi, McCain graduated from the Naval Academy in 1906. He served in surface vessels until 1935 when, as a captain, he became a naval aviator. He subsequently commanded two shore stations and the carrier *Ranger.*

In January 1941, now a rear admiral, McCain became Commander, Aircraft, Scouting Force, in the Atlantic. Transferring to the Pacific, he then planned and directed all land-based air operations during the Guadalcanal campaign from May to October 1942. He next headed the Bureau of Aeronautics until August 1943, when he was promoted vice admiral and became deputy Chief of Naval Operations (Air).

McCain left Washington in August 1944 to command a carrier group in the Pacific, with which he participated in the Marianas campaign, the Battle of the Philippine Sea, and the Leyte Gulf operation. On 30 October, he replaced Vice Admiral Marc Mitscher as commander of Task Force 38, which he led until January. After returning to Task Force 38 on 28 May 1945, McCain led the fast carriers through the final month of the Okinawa operation and into Japanese waters for a series of devastating attacks on Japan's home islands that virtually eliminated the remaining warships of the Imperial Japanese Navy and, in concert with Army Air Forces raids, crippled industry and communications.

Hard service wore McCain down to barely 100 pounds. He flew home immediately after the Japanese surrender ceremony on 2 September but died on 6 September. He was promoted admiral posthumously.

Paul E. Fontenoy

See also

Bureau of Naval Aeronautics; Japan, Air Operations Against; Task Force 38/58; Tokyo Air Raids

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McCampbell, David S. (1910–1996)

The U.S. Navy's ace of aces. David S. McCampbell was born in Bessemer, Alabama, in 1910. He entered Georgia Tech, then received his appointment to the Naval Academy, from which he graduated in 1933. Due to the Great Depression, his commission as ensign was delayed one year. He completed Navy flight training in 1938 and served with the 4th Fighter Squadron before his transfer to USS *Wasp* as landing signal officer. After *Wasp* was sunk while on patrol off Guadalcanal in June 1942, McCampbell was returned to the United States. In August 1943, he was appointed commander of the 15th Fighter Squadron. After a training period, the squadron, made up of fighters, bombers, and torpedo-bombers, became the 15th Air Group and, on 10 April 1944, sailed for the western Pacific aboard USS *Essex*.

For the next seven months, the air group saw almost continuous combat, including two major air-sea battles. In June 1944, in the Battle of the Philippine Sea, McCampbell led his fighters, Grumman F6F "Hellcats," against a Japanese force of 80 carrier-based aircraft attacking the U.S. Fleet. McCampbell alone shot down seven of the enemy. The Japanese were routed. Later, in the Battle of Leyte Gulf, Commander McCampbell and his wingman intercepted a force of 60 land-based Japanese aircraft. After McCampbell shot down nine and his wingman five, the enemy abandoned the attack. The downing of nine enemy airplanes on one mission is unequaled in the annals of aerial combat. Immediately reassigned as target coordinator for a strike force of planes from three Third Fleet Task Groups, McCampbell's aircraft attacked the Northern Japanese Force, sinking four enemy aircraft carriers, one heavy cruiser, and one destroyer. By war's end, McCampbell's aerial victories totaled 34, with at least 20 more destroyed on the ground. He was awarded the Medal of Honor personally by President Franklin Roosevelt on 10 January 1945. Captain McCampbell continued his distinguished 31-year Navy career until his retirement in 1964. He died in Florida at age 86.

Charles Cooper

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McConnell, Joseph C. (1922–1954)

Korean War jet ace. Joseph C. "Mac" McConnell was born on 30 January 1922 in Dover, New Hampshire. He enlisted in the U.S. Army as a private in 1940. He graduated navigator training and in 1944 flew 60 missions in B-24s.

After World War II, he stayed in the Army and again applied for pilot school, receiving his wings in February 1948. When the Korean War broke out in June 1950, McConnell applied for combat service, and in August 1952 he joined the 39th Fighter Interceptor Squadron, 51st Fighter Interceptor Wing, in Korea. Flying an F-86F named *Beauteous Butch* after his wife, Pearl "Butch" Brown, McConnell scored his first victory on 14 January 1953.

On 16 February, he became an ace after downing his fifth MiG-15. On 12 April, during heavy action over MiG Alley, his plane was hit by a MiG piloted by Soviet ace Semen A. Fedorets. Even though his plane was badly damaged, McConnell put the jet in a high-gravity turn, eventually coming up on the Russian's tail. McConnell made Fedorets his eighth victory. Fedorets ejected and survived the war. McConnell, his plane billowing smoke, made for the Yellow Sea, where he bailed out and was rescued.

The next day, he was back in combat in *Beauteous Butch II,* downing his ninth MiG. He became America's second triple-ace on the morning of 18 May, scoring two victories. That afternoon he scored his sixteenth and final kill. Fearing that their top ace might get shot down and needing McConnell at home to raise morale, the Air Force brought him home before the 27 July armistice ended the conflict.

After his tour in Korea, McConnell and his family moved to Edwards Air Force Base, California, where he served as a test pilot. On 25 August 1954, he was killed testing a North American F-86H.

Ironically, Hollywood filmmakers had just completed shooting *The McConnell Story,* starring Alan Ladd and June Allyson. With McConnell's death, the final scenes had to be reshot. When the film debuted in 1955, most reviewers considered it a generally accurate portrayal of McConnell's life. One critic described it as a "weepy yet effective fictional biography of the heroic test pilot."

To this day, McConnell remains America's top jet ace, hav-

The leading American ace of the Korean War, Joe McConnell, scored sixteen victories. (U.S. Air Force) ing scored 16 victories in 106 sorties. He was also America's top Korean War ace and one of two triple-aces, the other being Major James Jabara. McConnell was awarded the Distinguished Service Cross and Silver Star for his service.

William Head

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McDonnell Aircraft

Major U.S. aircraft manufacturer. James S. McDonnell (1899–1980) founded the company in 1939 after working with several firms including Stout, Hamilton, and Martin. The company was intended to focus on military production of aircraft and parts. During World War II, it built subassemblies at its St. Louis plant. The XFD-1 Phantom prototype, ordered in 1943, first flew in January 1945. It became the first Navy jet ordered (March 1945) and was produced as the FH-1 60 in 1947–1948. This plane also accomplished the first jet landings and takeoffs in the carrier *Franklin D. Roosevelt* in mid-1946. A much improved version (larger engines and airframe), the F2H Banshee, first flew in January 1947, saw extensive service in Korea, and resulted in nearly 900 examples by 1953. The F3H Demon, though initially underpowered, was improved and saw more than 500 examples produced. The XF-85 Goblin was a tiny jet fighter designed to be dropped from a B-36. Two prototypes were built and flown as the world's smallest jet fighter (wingspan of but 21 feet and length of only 14 feet). The XF-88 Voodoo of 1948 seemed a failure until ordered into production in 1953, the first major McDonnell contract with the Air Force, as the improved F-101, which served for years in the air forces of the United States and Canada. They were the first USAF in-service aircraft to fly twice the speed of sound.

The F4H (originally F-110, later F-4) Phantom II first flew in 1958 and, thanks in part to Vietnam War needs, resulted in more than 5,000 manufactured when production stopped in 1979 in the largest non-Soviet fighter program since the F-86. The F-15 Eagle of 1972 led to more than 1,000 aircraft manufactured, as did the F-18 Hornet of 1978, but McDonnell lost contracts for the A-12 Avenger and F-23 projects. McDonnell took over Douglas Aircraft in 1967, becoming McDonnell Douglas, which in turn was taken over by Boeing thirty years later.

Christopher H. Sterling

See also

Boeing F/A-18 Hornet; Boeing F-15 Eagle; McDonnell F-4 Phantom II

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McDonnell Douglas Aircraft

When the McDonnell Douglas Corporation (MDC) came into being on 28 April 1967 as the result of the merger between the McDonnell Company and the Douglas Aircraft Company, it appeared to be a corporate marriage made in heaven. Unfortunately, the business partners had incompatible personalities. Their tumultuous 30-year union was finally dissolved in 1997 when, meekly, they were taken in as poor relatives by the huge Boeing family.

At the time of the merger the two partners had diversified and complementary strengths in the commercial sector (Douglas), the military aircraft sector (McDonnell and, to a lesser extent, Douglas), and the spacecraft-booster-missile sector (Douglas and McDonnell). It also had more limited strengths in the data-processing and electronic sectors as well as valuable design experience in the rotary-wing field. No other aerospace company in the world had a more balanced experience or enjoyed a better reputation.

In the commercial sector, the DC-8 had lost its initial lead (in terms of aircraft sold) to the Boeing 707 but was experiencing a strong revival as Boeing had been unable to match the stretched DC-8 Series 60 variants. Moreover, at the time of the merger the DC-9 was the world's best-selling twinjet (441 having been sold versus only 136 Boeing 737s). Yet Douglas never had the resources to come up with a competitor for the fast-selling Boeing 727 trijet and had misjudged the requirements of airlines for four-engine jumbo jets, thereby allowing the Boeing 747 to run away with the most lucrative segment of the jetliner market. Douglas was thus facing difficulties in managing and developing a smaller widebody aircraft to meet the requirements of American Airlines and other U.S. domestic carriers. Fortunately, McDonnell had the financial and managerial resources needed to see that program to maturity as the DC-10.

Faced with intense competition from Lockheed and its TriStar, the launching of the DC-10 program was complicated by the fact that James McDonnell and his advisers in St. Louis were not familiar with the peculiarities of the civilian market. A number of traditional Douglas clients were thus lost to Lockheed. Nevertheless, the DC-10 started pulling away from the TriStar after the initial domestic variant, the Series 10, was complemented in 1969 by two intercontinental variants, the Series 30 and 40. Moreover, in the late 1970s the Long Beach team was close to securing orders for stretched variants. Unfortunately, adverse publicity following two major accidents (caused by improper locking of an aft cargo door and unapproved maintenance practices) came at the same time as a downturn in the airline business.

Douglas, long the world leader in commercial transport aircraft, never got to develop another all-new jetliner as the conservative MDC senior management in St. Louis never fully supported proposals for twinjets such as the Advanced Medium Range Aircraft, Advanced Short-Medium Range Aircraft, and Advanced Technology Medium Range Aircraft. Thus, the only "new" jetliners to be placed in production after the DC-10 were nothing but modernized derivatives of the DC-9 and DC-10. The resulting MD-80 and MD-90 first flew in 1979 and 1993, and the MD-11 first flew in 1990. Another DC-9 derivative, the MD-95, flew only after MDC had been taken over by Boeing; this twinjet was then renamed the Boeing 717-200. The lack of all-new products was exacerbated by the marketing mistake of switching to MD designations instead of capitalizing on the strength of the long established Douglas franchise. Eventually, this led to the discontinuation of a long family of successful airliners; the final nail in the Douglas coffin was the Boeing takeover of MDC.

The merger of McDonnell and Douglas came at a time when the United States was heavily involved in the Vietnam War, a conflict in which two MDC products—the F-4 Phantom and A-4 Skyhawk—were the most numerous combat aircraft. Production of the A-4 and F-4 ended in the United States in 1979, but manufacture of the F-4 continued under license in Japan until 1981. By then, however, McDonnell Douglas had become the world's leading producer of combat aircraft, with development of the F-15 Eagle, F/A-18 Hornet, and AV-8B Harrier II having been authorized in December 1969, May 1975, and July 1976, respectively.

These successes were complemented by military contracts for two prototypes of the YC-15 STOL transport in 1972, for a KC-10 tanker derivative of the DC-10 in 1977, and for development of the C-17 Globemaster III airlifter and T-45 Goshawk carrier trainer in 1981. As all of these awards had been received before President Ronald Reagan took office, MDC was in an exceptionally strong situation when the new administration started an overdue buildup of U.S. forces.

Although in the 1980s MDC appeared to have a lock on the combat aircraft sector, it fell out of favor during the first half of 1991. First, the contract for the joint development with General Dynamics of the A-12 Avenger, a stealthy replacement for the carrier-based Grumman A-6 medium attack aircraft, was cancelled. Next, the Northrop/McDonnell Douglas YF-23 lost the Advanced Tactical Fighter competition to the Lockheed/Boeing/General Dynamics YF-22. MDC in St. Louis did get a consolation prize in June 1992 in the form of a development contract (followed later by production contracts) for its F/A-18E/F Super Hornet. Nevertheless, in order to keep production lines in St. Louis operating at satisfactory levels, MDC was forced to announce in late 1989 that responsibility for T-45 production would be transferred from California to Missouri.

The MDC military aircraft business suffered yet another major blow when the company failed to become, on its own, one of the contractors chosen to compete for development of the Joint Strike Fighter (JSF). In October 2001, partnered with Boeing Military Aircraft, the St. Louis team saw the X-32 lose the JSF competition to the Lockheed Martin X-35. The old McDonnell plant in St. Louis and the Douglas plant in Long Beach may soon follow the same path to oblivion as Douglas plants in Santa Monica, El Segundo, Tulsa, Chicago, and Oklahoma City.

Between April 1946, when its XHJD-1 twin-rotor helicopter made its first hover flight, and June 1961, when development work on its Model 86 skycrane was terminated, McDonnell had made several attempts to break into the rotary-wing sector. Seventeen years after the MDC merger, the company returned to that field when it acquired the helicopter business of the Hughes Corporation. Rights to the smallest (Model 269 and 300) of the three types of helicopters acquired from Hughes were sold by McDonnell Douglas Helicopters Company (MDHC) to Schweizer Aircraft in 1986. Conversely, MDHC continued manufacturing Models 500 and 530 light turbine helicopters and AH-64 Apache attack helicopters until the company was taken over by Boeing. In addition, MDHC designed the Model 600, an enlarged derivative of the Model 530, and the all-new Explorer, which was put into production in 1994. Boeing has since sold rights to the Explorer and to Models 500, 530, and 600.

In the United States, McDonnell had pioneered the design and manufacturing of manned spacecraft with the Mercury single-seat capsule, which first took a U.S. astronaut into space in May 1961. Its Gemini two-seat capsule last orbited the earth in November 1966, five months before the MDC merger. In August 1965, Douglas had won an Air Force contract for the Manned Orbiting Laboratory, which was to make use of a modified Gemini capsule. Unfortunately for MDC, that contract was terminated in June 1969 when funds had to be freed to cover the mounting cost of the war in Southeast Asia. MDC did win another spacecraft contract when NASA chose it to build Skylab. The first manned Skylab orbital mission was flown in May 1973. The third and

The top brass at McDonnell Aircraft were hoping for a production run of perhaps as many as 400 F-4 Phantom IIs when it was introduced. The Phantom went on to become the premier fighter of the west. More than 5,000 were built. (U.S. Air Force)

last Skylab mission ended in February 1974. Since then, MDC has been out of the spacecraft business as a prime contractor. However, it remained active in the booster and missiles field until taken over by Boeing in 1997.

René Francillion

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McDonnell F-4 Phantom II

The primary Western fighter during the 1960s and 1970s. All told, 5,195 Phantoms were built in 17 major variants and were used in interceptor, fighter, bomber, reconnaissance, and defense-suppression roles. The F-4 was a highly capable aircraft for its time and was handicapped only by its large size and smoke footprint when in military power.

The Phantom II was designed and built to a U.S. Navy specification that called for a missile-armed Fleet Defense Interceptor and entered service in October 1961 as the F-4B. The U.S. Air Force adopted the Phantom as the F-4C in January 1964. Following experience in Vietnam, some F-4Cs were fitted with an SUU-16 Vulcan cannon pod and scored several kills despite the lack of an air-to-air gun sight. The F-4D entered service in March 1966 and had improved radar, weapons electronics, and a lead-computing optical gun sight. The F-4J entered service in December 1966 and was essentially an F-4B updated with many of the systems and structural changes found in USAF Phantoms. The F-4E was a significant revision of the basic F-4, achieving initial operational capability in October 1967. It had new solid-state radar and an internal 20mm cannon. Later F-4Es had wing leading-edge slats that greatly improved turn performance. The F-4F was built for the West German Bundesluftwaffe without Sparrow missile capability or leading-edge slats. F-4Gs were converted from F-4E airframes to perform the defense-suppression role and had the cannon replaced by Radar Homing and Warning equipment.

The F-4 saw combat in Vietnam, the 1973 and 1982 Arab-Israeli wars, the Turkish-Greek clash over Cyprus, and the Iran-Iraq war. The F-4B/C Phantom outclassed the MiG-17 in performance terms and was broadly comparable to the MiG-21F under typical combat conditions. It was, however, inferior to the MiG-19 in turns and acceleration to Mach 1.2.

The F-4K was built for the Royal Navy and first flew in June 1966. It was based on the F-4J but had updated systems and more powerful Rolls-Royce Spey turbofans, which required significant structural alterations. The F-4M was similar but was used by the RAF. It first flew in February 1967. The RF-4B, RF-4C, and RF-4E were reconnaissance versions of the standard F-4.

Andy Blackburn

See also

Aircraft Armament; Aircraft Carriers, Development of; BOLO; Gun Sights; Mikoyan-Guryevich MiG-17; Mikoyan-Guryevich MiG-21; Vietnam War

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McGuire, Thomas B., Jr. (1920–1945)

America's second-highest-ranking ace, with 38 aerial victories over the Southwest Pacific during World War II. Sharp, pugnacious, and "aggressive as hell," Thomas B. McGuire Jr. was born on 1 August 1920. McGuire attended Georgia Institute of Technology before enlisting as an aviation cadet in 1941. Graduating in February 1942, he served in the Aleutian Islands before joining the 431st Fighter Squadron, 475th Fighter Group, Fifth Air Force, in October 1943. In his first combat flying the Lockheed P-38 Lightning, McGuire shot down three Japanese aircraft over New Guinea; three days later he became an ace. Known for his spirited competition with Richard Bong for leading American ace, McGuire earned renown for shooting down three enemy aircraft in one day on five occasions. He also scored twin victories five times. On 25–26 December 1944, he downed three enemy aircraft over the Philippines, followed by four more the next day. For this remarkable exploit, he received the Congressional Medal of Honor. On 7 January 1945, less than a month before his scheduled return to the United States, McGuire banked his twin-engine Lockheed P-38 too tightly during a low-level dogfight, stalled, and crashed. A symbol of the brash, confident fighter ace, McGuire also provided leadership as a squadron commander and group operations officer. McGuire AFB, New Jersey, is named for him.

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Mediterranean Theater of Operations (World War II)

Important arena for airpower that played a critical role in the Allies' eventual victory over Germany. The air war in the Mediterranean theater lasted for five years. It began with low-key exchanges between British and Italian aircraft protecting their fleets. A high point, one that inspired the Japanese to adopt similar tactics in their attack on Pearl Harbor, was the attack on Taranto. German airpower proved decisive in the onslaught on the Balkans, swiftly overcoming all local resistance and driving the British out of Greece. The first airborne invasion of an island took place when the Germans invaded Crete.

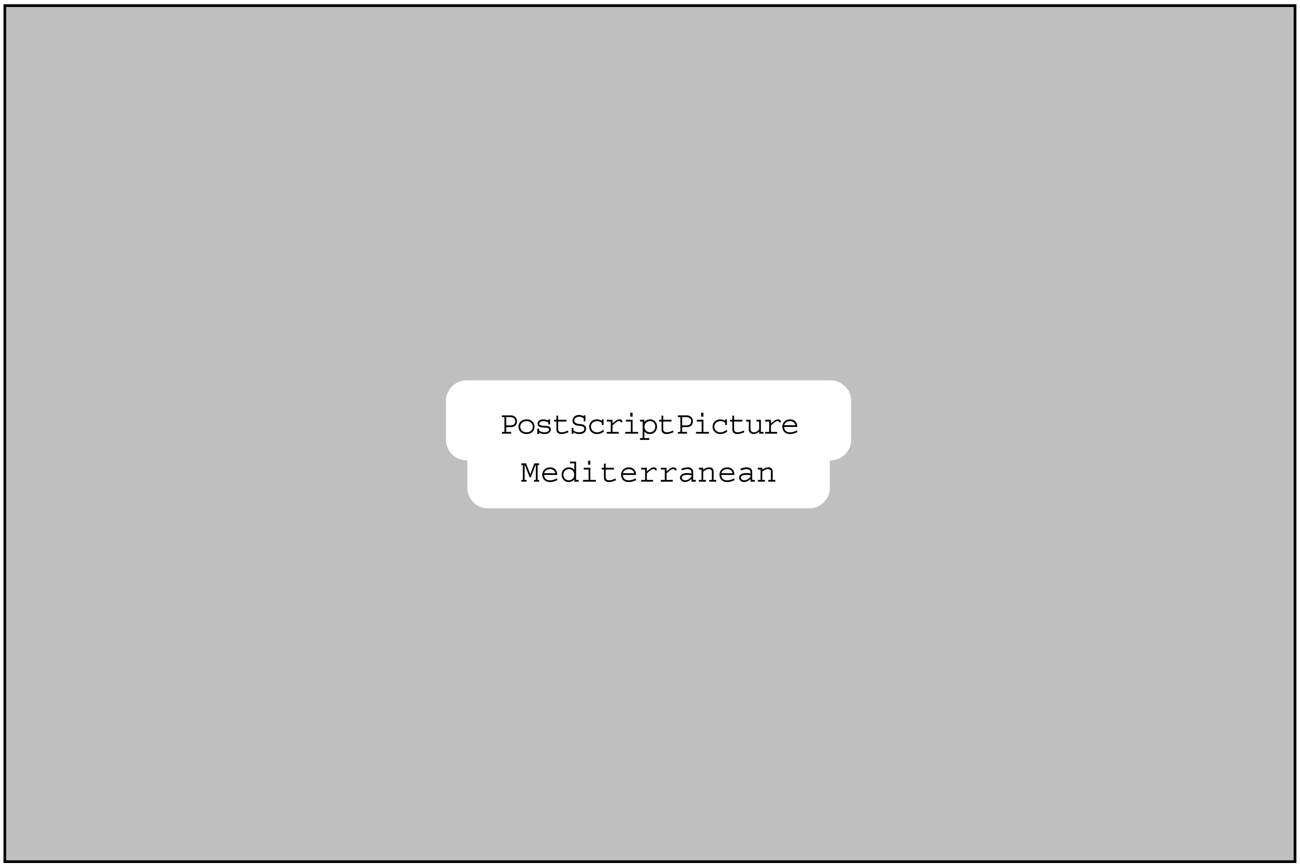
Germany made a key mistake early in the war by declining to take Malta when it might readily have been taken. Instead, it was decided to bomb Malta into submission, and a long, bloody, and eventually fruitless campaign was waged to do so. All the while, Malta served as a key base in the Mediterranean and eventually proved to be the tool with which the Allies strangled the Axis supply lines to Africa.

The Mediterranean theater also included some of the biggest invasions in history—those of North Africa, Sicily, Italy, and southern France. All of this fighting was conducted on an enormous front, one that actually exceeded the Eastern Front, for it extended 2,200 miles from Gibraltar to the Suez Canal and averaged about 500 miles in width. It was also conducted with a minimum of resources on the part of the Axis, for while Germany faced some 360 divisions in the Soviet Union, it faced only about eight divisions in Africa and dispensed its resources accordingly.

In the early part of the war the brunt of the fighting on the Axis side was borne by Italy's vaunted Regia Aeronautica, the Italian air force and a symbol of fascist pride. The force was relatively small, with about 1,800 first-line aircraft, and few of those were comparable to German and Allied counterparts. Among the exceptions were the Savoia Marchetti SM.79 "Sparviero" (Sparrow Hawk); a fabric-covered trimotor, it was one of the best torpedo-bombers of the war. Italian fighter planes were initially obsolete in concept and underpowered and undergunned, but they were eventually supplemented by modern designs such as the Macchi-Castoldi MC.202 "Folgore" (Lightning), which were equivalent to their opposition.

When British victories in North Africa forced Germany to intervene on Italy's behalf, the Axis gained temporary air superiority. The German Messerschmitt Bf 109Gs fighters and Junkers Ju 87 and Ju 88 bombers enabled General Erwin Rommel's Afrika Korps to throw the British back once again to Egypt.

On the Allied side, the British began the war with a rag-



tag collection of fighters and bombers that included the Gloster Gladiator and Bristol Blenheim. These were soon reinforced with Hawker Hurricanes and U.S.-built Martin A-30 Baltimores. When the United States began its participation, Curtiss P-40s, North American B-25s, and other, more modern aircraft took part.

For the Axis powers, the situation altered drastically for the worse after the fall of 1942. In October of that year, the British won the decisive Battle of El Alamein, and on November 8 the United States effected a landing in North Africa.

By this time Allied airpower had overwhelmed the Axis air forces, with fighter-bombers and medium bombers harassing German tanks and fortifications on a continual basis. The Germans made futile attempts to resupply North Africa by air, using Junkers Ju 52/3m and Messerschmitt Me 323 transports, vulnerable even when escorted. The greatest loss occurred on 18 April 1943, the famous Palm Sunday Massacre, when 78 aircraft were shot down, including 51 transports.

Complete Allied air dominance made it possible for land forces to overcome the hard-fighting Afrika Korps and eventually resulted in victory when the Germans surrendered at Tunisia on 13 May 1943. The losses matched those at Stalingrad, with more than 250,000 prisoners being taken. Perhaps the most important consesquence of the air war in North Africa—aside from the German surrender—was the establishment of effective tactics of close air support.

Airpower also proved decisive in the invasions of Sicily (July) and Italy (September). The Germans virtually abandoned any attempt to resist the Allies in the air, instead allowing ground forces to fight on with only occasional air support.

Italy, which Benito Mussolini had envisioned as a huge aircraft carrier dominating the Mediterranean, now became host to a series of air bases for U.S. aircraft, enabling Fifteenth Air Force bombers to attack Germany from the south.

Although the use of airpower in the Mediterranean Theater of Operations has not received the attention given other theaters of the war, it was extremely important and may fairly be said to have been the decisive factor that made Allied victory possible.

Walter J. Boyne

See also

Alam el Halfa, Battle of; Crete, Battle of; Curtiss P-40 Warhawk;

Hawker Hurricane; Pantelleria; Regia Aeronautica (World War II); Taranto Air Attack

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Menoher, Charles Thomas (1862–1930)

The first chief of the Army Air Service, remembered for his conflict over military aviation's future with visionary airman Billy Mitchell.

Menoher graduated from West Point in 1886 and began a career in the artillery with duty in Cuba and the Philippines. He was promoted to flag rank in 1917 and commanded the 42d (Rainbow) Division on the Western Front in 1917–1918. Menoher was appointed director of the Army Air Service on 23 December 1918, though he lacked a background in aviation. His appointment can be seen as validating the Army view that aviation was to be supportive and therefore should be under the command of ground forces. Use of aircraft for observation was more important than pursuit or bombardment activities.

In early 1919, Brigadier General William "Billy" Mitchell was named assistant chief of the Air Service. Menoher, because of his own lack of air experience, assigned Mitchell most planning and training responsibilities. When Mitchell used these as a platform to promote his views favoring a strong and separate air arm, senior War and Navy Department officials pressed Menoher to restrict his subordinate. Menoher relieved Mitchell of most duties, but this merely left Mitchell with more time to speak and write. The two men were barely on speaking terms. As General Hap Arnold later put it, Menoher was "not only unable and wholly unwilling to cope with Mitchell's ideas, but he could not handle Billy Mitchell. Also, to make matters worse, he did not fly much." Menoher headed a War Department board that concluded in 1921 that "whatever may be the decision as to a separate Aeronautical Department, the military air force must remain under the direct control of the Army."

In early October 1921, by now a major general, Menoher resigned his Air Service post, finding it impossible to operate with Mitchell (who remained in place through 1925). After further tours of command in Hawaii and San Francisco, Menoher retired in 1926. He died in 1930 and was buried in Arlington National Cemetery.

Christopher H. Sterling

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Mercedes Engines

Engines originally produced by the Daimler-Motoren-Gesellschaft. Emil Jellinek, an Austrian diplomat and Daimler dealer, helped design a Daimler car in 1899 that was named after his daughter, Mercedes. The Mercedes name became a registered trademark of Daimler in 1902.

Before World War I, four manufacturers produced aircraft engines in Germany: Argus, Benz, Oberursel, and Daimler. Daimler's Mercedes led the way in production, first with a four-cylinder 85-hp engine, followed by a six-cylinder 100-hp model. To stimulate the growth of the industry, the German War Ministry held a competition among engine manufacturers in January 1913; the winner was a Benz four-cylinder 105-hp engine, with the Daimler a close second. Despite its second-place status, the Mercedes became the most widely used German aircraft engine throughout the war, with its 160-hp model found in almost every make of airplane. An eight-cylinder model was also produced, but its longer crankshaft tended to crack during normal operation.

One manufacturer who did not have a supply of Mercedes engines was Fokker. The War Ministry was not enamored of Fokker machines and assigned the Mercedes to factories such as Albatros. Anthony Fokker accused the ministry of favoritism and claimed that he could create an excellent fighter plane if he were given Mercedes engines. Manfred von Richthofen had faith in Fokker and helped arrange a series of competitions among aircraft manufacturers in 1918, the winner to be supplied with Mercedes engines. Fokker won the first of the Adlershof Trials, and his machine was produced as the Fokker D.VII, one of the best fighter planes of the war. In 1926, Daimler-Motoren-Gesellschaft and Benz & Cie merged to create Mercedes-Benz.

Suzanne Hayes Fischer

Mercury Space Program

Pioneering space program that helped Americans reach the moon. Shortly after taking office in January 1961, President John F. Kennedy asked his advisers to investigate the viability of a space program that would catch up to the series of successes the Soviet Union had achieved since 1957, when it first orbited a Sputnik satellite. In 1959, the Eisenhower administration had presented to the public seven astronauts who would train for Project Mercury, which aimed to put an American in earth orbit. When Kennedy was elected, he appointed an ad hoc committee led by MIT's Jerome Wiesner, which determined that a civilian space program would help rally public support: Not only would there be heroes, but the nonmilitary spinoffs would likely be substantial in such fields as communications and weather observation. Kennedy was very much taken with the first side of the argument.

Although not specifically interested in the space program, Kennedy understood the potential of its impact in terms of peaceful demonstrations of prowess against the Soviets. Thus, despite warnings that considerable technical problems were yet to be resolved, Kennedy gave the go-ahead for further funding of Project Mercury, which was expected to orbit astronauts by 1965.

The immediate challenge was to find an appropriate booster by identifying the type of ICBM that could be used as safely as possible. However, cosmonaut Yuri Gagarin's successful orbit of the earth on 12 April 1961 accelerated interest in Mercury. Alan Shepard became the first American in space when he carried out a 15-minute suborbital flight on 6 May 1961. This paled in comparison to Gagarin's 89 minutes in full orbit and led many observers to warn that the United States, though a military leader, still was far behind in space technology. As a result of this new challenge from the Soviet Union, Kennedy ordered a reevaluation of the space program and, three weeks after Shepard's flight, gave a public address in which he committed the United States to landing a man on the moon by 1969.

Project Mercury proceeded apace and sent five more astronauts into space. John Glenn became the first American to orbit the earth on 20 May 1962. Astronaut Donald K. "Deke" Slayton, grounded by a heart condition, was the only one of the first seven astronauts not to fly in Mercury. With the shift in priorities, however, it became clear that Mercury would be insufficient to prepare for a moon landing, and the program was replaced by Gemini. Mercury represented a new phase in American culture's fascination with technology, whereby the seven astronauts acquired the status of movie stars and Americans generally embraced their newfound status as a spacefaring nation.

Guillaume de Syon

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Messerschmitt, Willy (1898–1978)

German aircraft designer. Willy Emil Messerschmitt grew up in Munich as the second son of a wine salesman. During World War I, he designed and built gliders (models S4 through S10) with the help of gliding pioneer Fritz Harth, a family friend. He later pursued his interests by studying engineering at the Institute of Technology in Munich.

In September 1923, he founded his own aircraft company in Bamberg and manufactured some of his gliders and several single-engine sportplanes (M 15, M 16, M 17). During this period, World War I flier and airline owner Theo Croneiss commissioned Messerschmitt to develop his first passenger plane, the M 18, which became his first all-metal plane, seating six. It was followed by the M 20 and M 24 models in the late 1920s, both of which were used by Lufthansa.

In 1927, Messerschmitt's company merged with the Bayerische Flugzeugwerke (BFW), based in Augsburg, Bavaria, which in turn led to the incorporation of the company with the financial help of family friends. In 1930, Willy Messerschmitt became a professor of aeronautical engineering at his alma mater in Munich. The worldwide economic depression caused a slump in German aircraft orders, forcing his factory to cut back on both design and production, although several projects already under way, such as the trainer M 27 and the postal M 28, were completed.

During that time, the BFW company survived in part thanks to small subsidies from the German Ministry of Transportation (then in charge of aeronautics). However, factory politics led to accusations of mismanagement against Willy Messerschmitt. In fact, the financial troubles of all German aircraft manufacturers make it difficult to support such charges (the main accuser, Fritz Hille, resigned his board membership to work for Heinkel). In the meantime, reorganization caused the complete incorporation of the Messerschmitt design bureau into BFW.

With the advent of the Third Reich, a new aeronautical structure was put in place that both served and hurt Willy Messerschmitt. He could count on the assistance of World War I ace and stunt pilot Ernst Udet, then in the new Air Ministry, but also had to deal with an unfriendly Erhard Milch, a former Lufthansa director who had canceled several Messerschmitt orders during the financial depression. As of 1935, the BFW factory was listed as the only holder of Messerschmitt designs; only in 1938 would the concern change its name to Messerschmitt.

During the Third Reich, Willy Messerschmitt served as acting president of the German Aeronautical Research Institute. During those years, he oversaw first the design of the Bf 108 Taifun, a four-seat civilian aircraft that was also one of the first German machines to incorporate retractable landing gear. It served as the basis for the development of the Bf 109 single-engine fighter (first used in the Spanish civil war). Other designs followed, some displaying Messerschmitt's remarkable design genius, such as the Bf 110 twin-engine fighter; others were ahead of their time, such as the Me 262, or far too impractical, from the Messerschmitt 264 long-range bomber to the Me 163 Komet rocket-glider fighter.

By the end of World War II, many German factories were producing Messerschmitt aircraft under license. Arrested in Murnau on 6 May 1945, Willy Messerschmitt was first flown to London, then back to Murnau, where he spent most of the following two years in camps or under house arrest.

After his release, Messerschmitt sought to diversify into new technological endeavors. Initially, a series of prefabricated buildings was sold as a way to deal with the housing shortage. Other projects included sewing machines and three-wheeled automobiles (with lowered gas consumption) affectionately known to Germans as "Isetta."

Offers to work with U.S. designers also came, but Messerschmitt declined them because of the Allies' refusal to allow him to regain control of his Augsburg factory to rebuild aircraft.

Messerschmitt also worked as an adviser to the Spanish aircraft industry and, together with aeronautical engineer Julius Krauss, oversaw three designs: the HA 100 training plane (roughly equivalent to the T-28 Trojan), the HA 200 jet trainer (used by both the Spanish and Egyptian air forces), and the HA 300 jet fighter. The latter was sold to Egypt, but Soviet interference interrupted further development of the project. After West Germany's admission into NATO in 1955, Messerschmitt was able to reopen the Augsburg factory. There he produced under license aircraft for Germany, France, and NATO, such as the Fouga-Potez CM-170, the Fiat G.91, and the Lockheed F-104G. A VTOL fighter project, the VJ 101, was also flight-tested in the 1960s but was canceled.

In 1968, Willy Messerschmitt was named CEO of the newly created Messerschmitt-Bölkow-Blohm aerospace concern, which helped produce the Panavia Tornado multirole fighter as well as several helicopter models. In 1973, he became chairman of the board; he died in 1978.

Guillaume de Syon

See also

German Air Force (Luftwaffe); Goering, Hermann; Heinkel Aircraft; Paris Air Agreement; Udet, Ernst

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Messerschmitt Bf 109

The most famous fighter of the German Luftwaffe, produced in greater numbers (in excess of 30,000) than any other fighter aircraft. Created by Willy Messerschmitt and his chief engineer, Walter Rethel, the Bf 109 was the world's most advanced fighter at the time of its first flight in September 1935. A development of the very successful four-place touring Bf 108, the Bf 109 featured retractable landing gear, an enclosed cockpit, all-metal stressed-skin construction, heavy armament for the time, slotted trailing-edge flaps, and automatic Handley Page leading-edge slots.

Despite the pressures for ever-increasing production, the Bf 109 went through a long series of modifications, the last production version being the Bf 109K. In the process, horsepower was increased from the prototype's 695-hp Rolls-Royce Merlin to the 2,030-hp Daimler-Benz DB 605 engine in the Bf 109K.

The aircraft served in every theater in which the Germans fought and was used by many nations allied to Germany. In the early months of the war, it reigned supreme over the battlefield until it met its match in the Supermarine Spitfire. As the war progressed and new Allied fighters such as the Soviet Yak-3 and U.S. North American P-51 were introduced, it became increasingly difficult for the Bf 109 to compete on equal terms. Nevertheless, in the hands of a capable pilot it remained a dangerous weapon until the end of the war. Versions of the Bf 109 were produced in Czechoslovakia and Spain, and it fought again in the 1948 Israeli War of Independence.

Although it was the favorite mount of many top German aces, Allied pilots who flew test versions had mixed feelings. The cockpit was cramped, with visibility limited by the heavy frames of the canopy. By Allied standards, the control harmony was poor, a problem that was amplified by the inexplicable lack of a rudder-trimming device. At cruising speeds, the Bf 109 was generally considered delightful to fly, but its controls became very heavy as speed increased. The most notorious aspect of the Bf 109 was its appalling takeoff characteristics. An estimated 3,000 aircraft were lost during takeoffs in which the pilot lost control. Landing characteristics were also challenging, but the a skilled pilot could land in a relatively short distance, using heavy braking once the tailwheel was firmly planted on the ground.

Walter J. Boyne

See also

Meserschmitt, Willy

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Messerschmitt Me 163 Komet

Tailless rocket-powered fighter conceived by Alexander Lippisch, whose design career began with the Zeppelin-Werke in 1918. Design of the piston-engine Lippisch DFS 194 tailless demonstrator aircraft began in 1938. Negotiations with Messerschmitt to take sponsorship of the program resulted in the DFS 194, and work on the Me 163 detail design was under way in September 1939. In February 1940, work on the Me 163 was shelved, and the DFS 194 design was revised to accept a Walter 882-pound/thrust rocket engine. Using hydrogen peroxide and potassium permanganate fuel, it flew in August 1940 at 342 mph.

The successful demonstration led to reprioritizing the Me 163 program, and work on the three prototypes resumed, powered by a 1,650-pound/thrust HWK 309 engine. Powered flights began in August that year, and ultimately a speed of 628 mph was achieved. A jettisonable two-wheel dolly was used for takeoff and a retractable belly skid for landing. Despite being unsatisfactory, this feature was carried over to the B production models.

A major redesign of the A model, the Me 163B prototype was rolled out in April 1942 and flew as a glider on 26 June 1942. Because of the unavailability of the engine, the first powered flight was not until 24 June 1943. The fuselage was as a two-piece metal monocoque construction, and the wings were all wood. Armament was two 30mm cannons. The fuel and engine systems were very unreliable. Leaking fuel could literally dissolve the pilots, and engines often failed.

A training unit was formed in late 1942, well before the first powered flight, operating from Peenemünde airfield. The first operational missions of the Me 163B were in May 1944, but its short range and low reliability did not allow actual engagements until August. The Me 163Bs never became a significant threat, although 279 Komets were delivered before the end of the war.

Douglas G. Culy

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Messerschmitt Me 262

The first mass-produced operational jet fighter in the world. The aircraft looks advanced even today, with a streamlined fuselage, mildly swept wings, and two Jumo 004 turbojets mounted in nacelles under the wings. Initial flights of the airframe were conducted using a nose-mounted Jumo 210Ga piston engine and conventional propeller; the first flight under jet power took place on 25 March 1942, although the piston engine was still installed. Development continued among great political turmoil. Nevertheless, on 26 July 1944, Lieutenant Alfred Schreiber from Kommando Thierfelder shot down an RAF Mosquito reconnaissance aircraft in the first aerial victory by a jet fighter.

The Me 262 did not have a material impact upon the outcome of World War II. Less than 200 Me 262s were in operational service at any one time, despite the efforts of Messerschmitt to manufacture more than 1,400 of them in the last 18 months of the war. The Me 262 was produced in day-fighter, night-fighter, fighter-bomber, and reconnaissance versions.

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The problems lay not with the aircraft, or even with the questionable political decisions concerning its role and manufacture. The problem was simply one of technology: Junkers could not produce enough reliable engines to power all the airframes that Messerschmitt was capable of building. The Allies certainly influenced this problem; heat-resistant materials were difficult to obtain in Germany toward the end of the war, and constant bombing raids disrupted production and distribution of critical parts. Completed airframes were strafed and bombed even before they could be delivered. Simply put, even if Hitler had allowed the Me 262 to enter production without demanding that its role be changed from fighter to fighter-bomber, Junkers could not have produced sufficient engines to power them.

The Me 262 was actually very much a compromise aircraft, and its designers were not particularly happy with many aspects of it. The advanced swept wing was an inelegant solution to a late engine change that significantly altered the center of gravity, and the underslung nacelles were a solution to oversized and overweight power plants. The aircraft had precious little serious wind-tunnel time and a disappointingly low critical Mach number. In all, like many aircraft before it, the Me 262 was simply the best that could be built given the circumstances.

Dennis R. Jenkins

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Meyer, John C. (1919–1975)

World War II fighter ace; USAF vice Chief of Staff and commander of Strategic Air Command.

Born in Brooklyn, New York, he entered aviation training in 1939 and graduated in July 1940. He began his wartime career flying convoy patrols out of Iceland. In 1943, he took command of the 487th Fighter Squadron, 352d Fighter Group, Eighth Air Force.

From October 1943 through January 1945, Meyer flew 200 combat missions and logged 462 combat hours. During this time, he shot down 24 German aircraft in aerial combat and destroyed an additional 13 on the ground, making him the top-ranking U.S. ace in Europe in total aircraft destroyed. He ranked fourth in the Eighth Air Force in aerial victories and was the seventh-ranking U.S. Army Air Forces ace in World War II. His World War II combat career ended on 9 January 1945, after he sustained serious injuries in an automobile accident.

After the war, Meyer completed his college education at Dartmouth and in 1950 took command of the 4th Fighter Interceptor Group, which he took to Korea. In that conflict, he flew 31 combat missions in the F-86 Sabre Jet, downing two MiG-15s to add to his already impressive aerial victory total. In April 1951, he moved up to deputy commander of the 4th Fighter Interceptor Wing.

After the Korean War, Meyer continued to advance in rank, holding numerous key military positions until he attained his fourth star. In 1969, he was named vice Chief of Staff of the U.S. Air Force. He served in this post until 1972, when he assumed command of Strategic Air Command—only the second fighter pilot to hold that position. He retired from the Air Force in July 1974 and succumbed to a fatal heart attack in December of the following year while jogging.

Meyer's many decorations include the Silver Star with one Oak Leaf Cluster and the Distinguished Service Cross (DSC) with two Oak Leaf Clusters. He remains the only U.S. Air Force officer to have earned three DSCs. In 1988, Meyer's career was further validated by his induction into the prestigious National Aviation Hall of Fame in Dayton, Ohio. With a total of 26 aerial victories in two wars, General John C. Meyer is the ninth-ranking U.S. fighter ace of all time, an honor he shares with World War I ace Eddie Rickenbacker and World War II Marine Corps ace Joseph Foss.

Steven A. Ruffin

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Midway, Battle of (1942)

The turning point that reversed Japanese military expansion in the Pacific during World War II. At Midway, the United States gained the strategic offense and never relinquished it.

The Doolittle Raid on 18 April 1942 settled a debate between Japanese factions over whether to take Midway. Because its duty was to protect the emperor, the military could not allow such a raid to happen again. Besides taking Midway, Japan planned to extend its reach north toward the Aleutians and south toward Australia. This led to the Battle of the Coral Sea, the first sea battle fought entirely through airpower. The U.S. lost the carrier *Lexington,* and Japanese aviators thought they had also sunk the *Yorktown.*

The Japanese expected that they could take Midway and then wait for the remaining two U.S. carriers to be lured into battle and destroyed. But the Americans had broken the Japanese code and planned an ambush of their own.

At Pearl Harbor, workers patched up the damaged *Yorktown* and got it into the fight at Midway, where four Japanese carriers were stalked by three U.S. carriers. In addition, Midway Atoll had torpedo-bombers, fighters, scouts, and bombers. From an aerial-resources standpoint, the fight was shaping up to be somewhat even. Surprise was on the U.S. side, but the Japanese had superior planes.

Early on 4 June 1942, Admiral Chuichi Nagumo launched aircraft to strike Midway, holding others back for protection against enemy ships. He had two objectives: knock out the Midway defenses, and sink any hostile ships, especially carriers. This double responsibility compromised Nagumo's ability to do either mission well.

U.S. scout planes sighted the Japanese carriers and aircraft headed for Midway, and all serviceable planes left the atoll. U.S. bombers and torpedo-bombers flew toward the carriers. Grumman Wildcats and aging Brewster Buffaloes headed for the incoming aircraft. The Japanese shot up these U.S. fighters, then bombed and strafed Midway.

Starting at about 7:00 A.M., four Martin B-26 Marauders, each carrying one torpedo, and six Douglas TBF Devastator torpedo-bombers attacked the Japanese carriers. Defending Mitsubishi Zeros shot down all but one of the torpedo-bombers and half of the B-26s. The few torpedoes the Americans launched missed.

Fourteen Boeing B-17s bombed from high altitude; all bombs missed as the ships maneuvered out of harm's way. Sixteen Marine dive-bombers made a glide-bombing attack because their pilots were not experienced enough for dive-bombing. Zeros shot down half of them, and the rest missed their targets. A similar fate befell the 12 older Vought Vindicators that went in next.

Nagumo ordered a second strike on Midway. This meant that deck crews had to switch general-purpose bombs for torpedoes and armor-piercing bombs. When the planes of the first wave returned to be retrieved and refueled, the crews had to take the second strike force below deck.

Unexpectedly, a search plane reported sighting a U.S. carrier within striking distance. Nagumo now ordered planes to be rearmed to attack the carrier instead of Midway. Crews switched torpedoes and armor-piercing bombs back for the regular bombs. There was not enough time to observe proper safety precautions. They stored gasoline tanks, bombs, and torpedoes all over the flight and hangar decks, making the Japanese carriers extremely vulnerable. Admiral Raymond Spruance launched his planes to where he thought the enemy carriers were.

However, Nagumo had turned his ships toward the Americans. When U.S. pilots did not find their quarry, they spread out in a search mode. Some eventually turned back because of low fuel; the rest arrived at their targets in piecemeal fashion. The Douglas TBD torpedo-bombers from the *Hornet* attacked first. Zeros from the combat air patrol dropped down on them, and eventually all were shot down; only one man, Ensign George Gay, out of 30 survived. The *Enterprise's* torpedo squadron saw smokescreens from the Japanese destroyers and headed toward them. They divided in order to attack from two directions, but this made them more vulnerable to the Zeros because the rear gunners' combined fire was diminished. Ten out of 28 men survived. The torpedo-bombers from the *Yorktown* arrived next. Again the defending Zeros were all over them. Carrying a torpedo, the Devastators could fly only at 100–120 mph and were sitting ducks. Only three persons survived out of 24 in this attack.

The Japanese appeared to be near victory. They were now ready to attack the U.S. ships. However, as their carriers swung into the wind, Douglas SBD Dauntless dive-bombers finally arrived at the battle—undetected. The Japanese carriers had no radar, and there was just enough cloud cover to hide the bombers from the lookouts. The Zeros were down low, finishing off the torpedo-bombers, and had not had enough time to climb to altitude.

The dive-bombers dove from out of the sun. Only two to four bombs hit each carrier but this was enough. The armed and fueled planes, as well as the munitions and gasoline containers scattered around, began exploding. The SBDs from the *Enterprise* hit the *Kaga* and the *Akagi,* while the *Yorktown* dive-bombers hit the *Soryu.* In five minutes, these three carriers were blazing infernos. The exploding torpedoes and bombs made it impossible to bring the fires under control. The fighting continued, and the carriers *Hiryu* and *Yorktown* were sunk later. The Japanese had been defeated, and the course of the war was irrevocably changed.

Emerson T. McMullen

See also

Coral Sea, Battle of the; Nagumo, Chuichi; Spruance, Raymond A.

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MiG Aircraft

See Mikoyan-Guryevich Aircraft

Getting ready for takeoff, North American F-86s prepare for the trip up to MiG Alley. (U.S. Air Force)

MiG Alley

The 6,500-square-mile airspace in northwestern Korea where United Nations and communist jets fought for air superiority during the Korean War. On a map it resembled a parallelogram extending north to Suiho, south to Sinanju, west to Sinuiju, and east to Huichon. Most combat had an operational ceiling of 50,000 feet and was between U.S. Air Force F-86 Sabre Jets and Soviet-built Chinese MiG-15s from mid-1951 to mid-1953. Ultimately, the F-86s amassed 792 MiG kills and 78 losses.

Before the war began in June 1950, communist forces built a MiG base near the Manchurian border city of Antung (Dandong) to guard the important rail bridges over the Yalu River. This base and other targets in or near China became MiG havens.

On 8 November 1950, a USAF F-80 Shooting Star shot down a MiG-15 in the first jet-versus-jet combat. Even so, it soon became clear that the MiGs were better than the F-80s and F-84s, and U.S. officials deployed F-86s to Korea.

The MiGs possessed superior high-altitude characteristics, which the F-86s could overcome by high-speed dives that brought the dogfight to more favorable low altitudes. Moreover, USAF fighters were stationed in South Korea far from MiG Alley. They could not stay long for fear of running out of fuel. Being close to their bases, MiGs could loiter for long periods, choosing the time and circumstance of their attack.

With UN leaders concerned that the war might widen to include China and the Soviet Union, one of the most frustrating problems for USAF pilots was the politically imposed restrictions on attacking MiG bases and other targets in China or near its border. Bases like Antung were off-limits, although many F-86 pilots slipped across the border to engage and down enemy MiGs.

Another problem was the lack of F-86s. At the height of combat the USAF only had the 4th and 51st Wings, with 115 fighters in Korea. The enemy had nearly 500 MiGs at Antung. Keeping F-86 wings supplied and their aircraft airworthy was also difficult, and by early 1952 mission-incapable rates reached as high as 45 percent. Many F-86 missions faced three-to-one or four-to-one odds.

Later in 1952, the introduction of F-86Fs with more powerful engines, better wing and tail designs, and the A-1 radar-computed gun sight turned things decidedly in the USAF's favor. U.S. pilots were typically better trained and often had experience from World War II. Their more aggressive style meant that 37 F-86 pilots became aces. The top ace was Captain Joseph McConnell, with 16 kills.

The MiG pilots' abilities varied. Some, especially Soviet pilots, were excellent. U.S. pilots respected these men as the "honchos," but most others were not well trained and hence were called "nimwits."

One effective MiG tactic sent as many as 80 jets on a rapid sweep called a southbound "train." This proved deadly at first, but by late 1952 U.S. MiG combat air patrols began to employ countertactics that devastated MiG trains. The last combat over MiG Alley came on 22 July 1953, when Second Lieutenant Samuel P. Young shot down his first and only MiG-15.

William Head

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Mikoyan, Artem I. (1905–1970)

Military aircraft designer of the former Soviet Union. Born the son of a carpenter in a small village in modern-day Armenia, Artem I. Mikoyan benefited, especially in the 1930s, from the career of his brother Anastas, who was a colleague of Soviet dictator Joseph Stalin and was a leader in the Communist Party and Soviet government. Meanwhile, Artem attended a village school and then high school in Tiflis (Tbilisi), Georgia. He completed his early education by taking a machinist course at a technical school in Rostov in 1923. The following year he worked as a mechanic in the local railway shop before moving to Moscow and being employed at the Dynamo factory. After finishing an obligatory tour of duty with the Red Army, Mikoyan entered the air force academy in 1931, where he learned to fly as well as design advanced aircraft. Graduating with honors in 1937, he became the Red Air Force permanent representative with the design bureau headed by Nikolai N. Polikarpov.

At the Polikarpov design bureau, Mikoyan eventually assumed responsibility over the production of the I-153 fighter. Mikhail I. Gurevich, who would prove to be his collaborator for 25 years, assisted Mikoyan in this effort. Members of the Soviet military and government, including Stalin, recognized that the Soviet Union needed a modern fighter different from the obsolescent, biplane-configured I-153. At the end of 1939, the Soviet hierarchy encouraged the formation of a new experimental department to create a modern fighter under the leadership of Mikoyan (chief) and Gurevich (deputy). Together they designed the I-200, a low-wing monoplane that first flew in March 1940. The new aircraft required extensive modification before it was ready to begin a small production run in December 1940. By then, the model name had changed to the MiG-1, a designation based on the initials of the last names of the designers separated by "i," the Russian word for "and." The most successful of the early planes was the MiG-3, which enjoyed a production run of 3,300 and provided interceptor defense for the Soviet Union's metropolitan centers during World War II. Other wartime MiG designs showed promise but were not significantly better than those fighter aircraft, such as the La-7 and Yak-9, that entered mass production.

After the war, Mikoyan and Gurevich examined German technology and merged two BMW 003 turbojet engines with the MiG-3 airframe to create one of the Soviet Union's first jet fighters in April 1946. The MiG-9 proved to be the successful precursor of a line of famous fighters, ranging from the Mig-15 to the MiG-31. Until a stroke disabled him on 27 May 1969, Mikoyan was manager and general constructor of the MiG OKB (Experimental Design Bureau). He received numerous awards and honors for his outstanding design achievements in military aviation, including membership in the Soviet Union Academy of Sciences in 1968.

James K. Libbey

See also
Gurevich, Mikhail I.; Lavochkin Aircraft; Mikoyan-Gurevich Aircraft; Polikarpov, Nikolai N.; Soviet Air Force; Yakovlev, Aleksandr S.

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Mikoyan-Gurevich (MiG) Aircraft

Soviet aircraft design bureau specializing in fighter aircraft. Artem Ivanovich Mikoyan joined with Mikhail Iosifovich Gurevich and in 1939 established an independent design bureau. The result of their first efforts was the MiG-3, one of the new fighters that was supposed to replace the old Polikarpovs by 1942. It did not perform well at the low altitudes where most air combat occurred on the Eastern Front and was considered a relative failure. Production ended prematurely in 1942 after only 3,322 were completed. None of MiG's other wartime efforts progressed beyond the prototype stage.

In 1945, MiG began to design the MiG-9 jet fighter, powered by two RD-20 engines copied from the BMW 003A. It first flew on 24 April 1946, with 664 being built. The next design, the MiG-15, made the acronym "MiG" synonymous with most all Soviet aircraft.

Design of the MiG-15 began in 1946 and used the RD-45 engine, a copy of the Rolls-Royce Nene shared by the British government (later versions used the improved VK-1). It first flew in May 1948, and by October the first MiG-15s were leaving the factories and entering service. With a top speed of 641 mph, a ceiling of 49,900 feet, and an armament of one 37mm and two 23mm cannons, it was the first Soviet fighter equal or superior to all its foreign competitors.

Just as the Zero was a nasty surprise to the United States in 1941, so was the MiG-15 when it appeared over North Korea in 1950. (U.S. Air Force)

The MiG-15 first saw combat over Shanghai in April 1950. As with the Japanese Zero a decade before, Western observers were not paying attention, and the appearance of the MiG-15 over Korea in November 1950 was a shock. The MiG-15 and the North American F-86 Sabre were roughly an equal match, the MiG slightly better in climb at altitude and in maneuverability in the vertical plane, the Sabre faster in a dive, with better horizontal maneuverability. The MiG had better weapons, but the Sabre had the better gun sight. Success depended on the skill of the individual pilots and the specific tactical situation. None of the other U.S. or British aircraft really had a chance.

After Korea, the MiG-15 saw further combat in the Middle East and was widely sold to all the Soviet Union's allies and to most of the newly emerging nations. Almost 10,000 were produced by the mid-1950s, including production by Poland and Czechoslovakia. In addition to the single-seat fighter, there was also a two-seat fighter-trainer, the MiG-15UTI, of which about 6,700 were built. The MiG-15UTI was even more widely sold than its single-seat brother and remained in use in the Soviet Union until the end of the 1980s.

From 1951 to 1956, the MiG-15 was supplanted in production with a modernized version, the MiG-17. Neither the MiG-15 nor the MiG-17 was capable of supersonic flight, which was finally achieved by the MiG-19 series (in production from 1954 to 1961). Only 3,700 MiG-19s were produced; it was sold widely, but it had the misfortune to appear between the exceptional and long-lived MiG-17 and the equally successful MiG-21.

Gurevich retired from the bureau in 1964; he died on 12 November 1976. Mikoyan died on 9 December 1970 and was succeeded by Rostislav Apollossovich Belyakov (b. 1919), who had long been MiG's chief designer. At this time, the MiG-23/MiG-27 family was entering production. Although the Sukhoi Su-17 was the first operational variable-geometry aircraft, the MiG-23 and MiG-27 were more distinctive, recognized first, and produced in greater numbers. From 1969 to 1982, 4,278 examples of the MiG-23, 910 MiG-27s, and 769 MiG-23UMs were produced. The MiG-23M and MiG-23P variants and derivatives were optimized for air combat and interception, respectively, and were distinguished by an ogival nose cone containing advanced radar systems. The MiG-23B variants and the MiG-27 were dedicated fighter-bombers, without air-to-air radar systems but with more flexibility for carrying bombs and rockets, and they had specialized ground targeting laser systems. These aircraft were distinguished by a sloping forward fuselage, which gave the type its Russian nickname, "Utkanos" (Ducknose).

Too late for combat over Vietnam, the MiG-23 family has participated prominently in all the conflicts since then in the Middle East and Africa and has been exported to dozens of nations. By 1982, when Syrian MiG-23s tried to fight over Lebanon's Bekaa Valley, they were flown by pilots less experienced than the Israelis and were pitted against F-16s and F-15s, fighters of an entirely later generation. Also during the 1980s, MiG-23s had the misfortune to duel Pakistani F-16s over the Afghan border, which proved it was not merely Israeli skill at work over the Bekaa. The MiG-23 was retired from Russian service on 1 May 1998 but continues in service with former Soviet republics and other countries around the globe.

The cockpit of the MiG-17 may look somewhat primitive, but it was fully up to date at the time of its operational debut in late 1952. More than 6,000 were built, and it served throughout the Communist world. (U.S. Air Force)

Also entering service in 1969 was the MiG-25, a large interceptor capable of reaching Mach 2.8 at altitude. This aircraft was originally designed to counter the U.S. XB-70 and SR-71 and was produced in several reconnaissance variants. The MiG-25 (NATO code name "Foxbat") achieved notoriety in 1975 when Lieutenant Viktor Belenko flew an example to Japan, which allowed the United States to examine it thoroughly, revealing a curious mix of very advanced and antiquated technology. As a consequence, the Soviets introduced a drastically improved version, the MiG-25PDS, in order to restore their secrets. About 1,190 MiG-25s of interceptor, reconnaissance, and combat-trainer variants were produced by 1984. A further evolution of the basic MiG-25 design is the MiG-31. This aircraft is a highly modernized interceptor, with no reconnaissance or trainer variants included among the 500 or more produced between 1977 and 1986. In 1990, the further modified MiG-31M appeared, but the end of the Soviet Union and the decline of the Russian air force has prevented it from entering service.

The MiG-29 was the last MiG to be produced. The end of the Cold War and the collapse of the Soviet Union caused difficulties for most Russian arms producers, especially MiG. The political connections that earlier proved so advantageous now turned into a liability, as MiG was associated too closely with the old regime. At the same time, MiG was supplanted by Sukhoi, which experienced a flowering of design creativity and lacked the political baggage. In 1995, MiG was merged with the newly privatized aviation factories of the Moscow Area (Aircraft) Production Organization to become MiG-MAPO. A new design, the MiG-AT, has been offered in competition with the Yak-130 for the Russian air force's Advanced Trainer requirement.

George M. Mellinger

See also

Israeli-Arab Conflicts; Korean War; Mikoyan-Gurevich MiG-17; Mikoyan-Gurevich MiG-21; Mikoyen, Artem I.; North American F-86 Sabre; Polikarpov, Nikolai N.; Sukhoi Aircraft; Yakovlev, Aleksandr S.; Yom Kippur War

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Mikoyan-Gurevich MiG-17

In January 1949, the Soviet Mikoyan-Gurevich Design Bureau reassigned a large number of its aerodynamics staff to a new program in an effort to rectify basic deficiencies in the MiG-15 Fagot of Korean War fame. The 35-degree sweep of the MiG-15 was increased to 45 degrees. The empty weight was increased from 7,456 pounds for the MiG-15 to 8,664 for the first MiG-17. The speed was increased from 652 mph to 711 mph.

The MiG-17 proved to be a highly maneuverable aircraft. Coupled with its cannon armament, it became a formidable weapon, a fact attested to when it was first confronted during the Vietnam War. Returning U.S. fighter pilots demanded that guns be added to follow-on U.S. fighters.

Some 6,000 MiG-17Fs were produced by the Soviet Union. Under license, Poland produced about 1,000 LIM-5s (MiG-17Fs), and China made more than 2,000 of the aircraft.

The MiG-17 became one of the most numerous Soviet export fighters, bolstering air forces of Third World countries in Africa, Asia, and the Middle East, along with numerous Soviet bloc nations in Europe. As many as 40 nations operated the MiG-17. These aircraft have been in front-line service for more than 40 years—a testament to the reliability and maintainability of the basic design.

Alwyn T. Lloyd

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Mikoyan-Gurevich MiG-21

Although the MiG design bureau had been progressing toward supersonic flight via the MiG-15, -17, and -19, the appearance of the MiG-21 was a lesson in contrast. Instead of continuing the series with another swept-wing aircraft, the design bureau opted for the delta wing.

Developed from the outset as a lightweight point defense fighter, experimental airframes were flown in 1955 using an axial turbojet. Initially, armament was limited to cannons. The appearance of guided missiles on Western aircraft (AIM-9 Sidewinder) led to home-grown development (K-13 Atoll) with the help of espionage. First deliveries in the Soviet Union took place during 1958, and Warsaw Pact forces followed. Exports were made to such countries as Egypt and Syria.

In common with other aircraft, the MiG-21 underwent continued development; the second series of aircraft featured blown flaps to which was added an enlarged spine containing avionics allied to an improved radar. Weapons capability was later increased by the addition of improved missiles and a ground attack capability.

This new variant saw widespread service throughout the Soviet sphere and remains in use today. Total production exceeded many thousands of all variants, including a two-seat trainer.

Kev Darling

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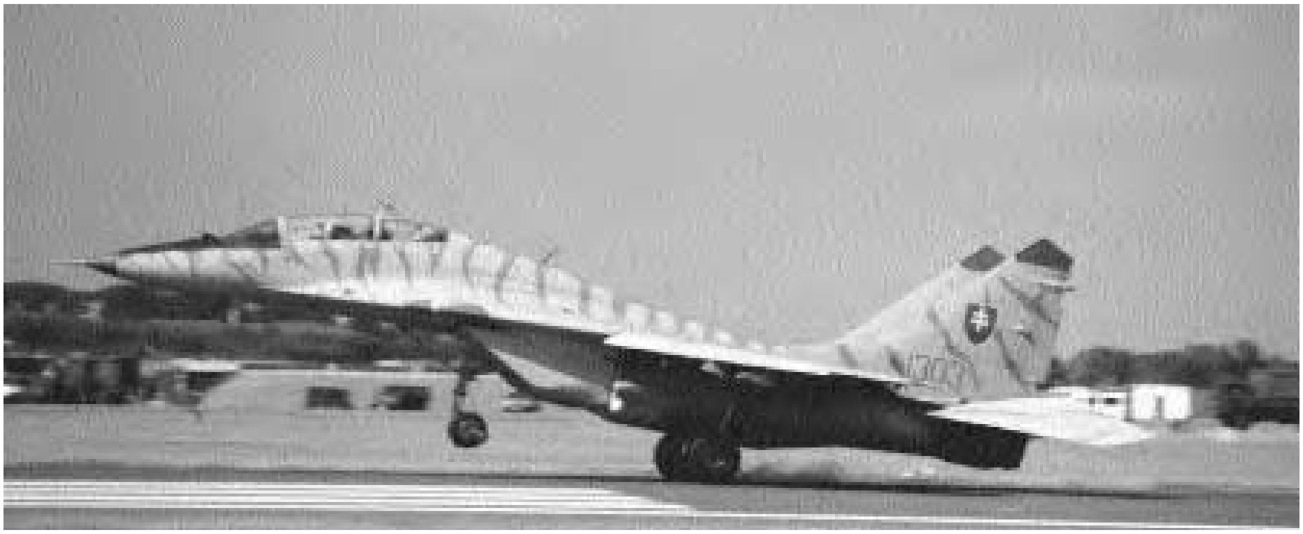
Mikoyan-Gurevich MiG-29

Soviet fighter. The appearance of the MiG-29 confirmed that the Soviet Union was not lagging behind in aircraft development. This agile fighter, first developed in the mid-1970s, was the Soviets' answer to the Grumman F-14, McDonnell Douglas F-15, and General Dynamics F-16.

The prototype flew in October 1977 and was followed by a series of development airframes. These underwent various changes to help evolve the type; production began in mid-1982. The following year, MiG-29s were delivered to operational squadrons of the Soviet armed forces. A two-seat trainer (Fulcrum-B) entered service at the conversion and squadron levels. The most prolific version to enter use, both in Russia and overseas, is the Fulcrum-C. This features the humped spine aft of the cockpit containing increased avionics. The Fulcrum-C entered service in 1987.

Other experimental and preproduction MIG-29s include the Fulcrum-D (or K), intended for naval service aboard the Russian carrier *Tbilisi* and featuring a strengthened undercarriage, arrester hook, folding outer wings, and revised avionics.

Foreign operators of the Fulcrum include the Czech Re-



The MiG-29 was one of the most advanced aircraft in the world at the time of its first flight on 6 October 1977. Suitably updated, it remains a world-class fighter. (Big Bird Aviation)

public, India, Iraq, Germany, Poland, the Slovak Republic, Syria, and Yugoslavia. Other nations have ordered the aircraft in smaller quantities, including Cuba, Romania, and Iran. After the breakup of the Soviet Union, the supply of spares for these aircraft was initially spasmodic, although the situation was resolved for those countries paying in Western currency. The MiG-29 is destined to remain in service for many years as upgrades are proposed and implemented in weapons and avionics.

Kev Darling

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Mil Aircraft

One of two Russian design bureaus specializing exclusively in helicopters. Mikhail Leontevich Mil was born in Siberia in 1909; after graduating from an engineering institute in 1931, he became involved in the development of autogyro aircraft and worked as an assistant to Nikolai Kamov. He formed his own design bureau in 1947, and his first design, the Mi-1, entered production in 1951. This small, two- or three-seat craft was the first helicopter in the Soviet Union to enter significant service, with about 2,700 being produced in the Soviet Union and Poland by the time it was replaced.

The Mi-2 successor was larger and much more powerful, using a turbine engine, and was able to carry up to eight passengers in addition to the pilot. Tremendously successful, the Mi-2 remained in production for 30 years, with 5,450 examples completed, primarily in Poland, which was licensed by Mil and the Warsaw Pact as the sole producer. The Mi-34 successor, dating from the 1990s, has proven unable to replace its predecessor.

The Mi-4, produced from 1953 to 1964, was the first Soviet helicopter to enter service with a significant load-carrying ability. With an appearance much like the Sikorsky S-55, the Mi-4 was able to carry 12 troops and also was produced in antisubmarine warfare (ASW), gunship, and civil transport variants. With 3,200 Mi-4s produced by 1964, it provided the backbone of Soviet helicopter forces until gradually replaced by the Mi-8 and was widely exported to Soviet clients.

The Mi-6 entered service in 1957 as the first Soviet heavy-lift helicopter. It was capable of carrying 90 troops or up to 8 tons of cargo, including small armored vehicles. It remained in production until 1980, and some of the 874 Mi-6s were sold to foreign countries, including Iraq and North Vietnam. Even bigger was the Mi-10, a flying crane; only 80 were produced during the 1960s.

The true successor to the Mi-6 was the Mi-26, capable of carrying up to 25 tons. Since 1983, 300 Mi-26s have been produced. Brief mention should also be made of the experimental V-12, flown in 1969 and easily the largest helicopter ever. This monster was powered by four turbine engines, mounted in pairs at the end of long, winglike sponsons, each pair driving a five-bladed rotor.

The most important helicopter was the Mi-8, which entered production in 1966 as a replacement for the Mi-4. With the nominal ability to carry 4 tons of cargo or seats for

24 troops, the Mi-8 often carried more. It also operated as an electronic warfare platform, and in one of its major armed configurations it was the most heavily armed gunship of all time, carrying four wire-guided antitank guided missiles and six pods of 32 57mm rockets, in addition to a heavy machine gun. By the mid-1980s, more than 8,600 Mi-8s (and the Mi-17 variant) had been built and were in service with every military that used Soviet weapons. During the 1990s, many updated and more heavily armored versions were offered, though the classic Mi-8 remained in wide service.

Equally famous has been the Mi-24 Hind dedicated attack helicopter, of which about 2,600 were produced by 1990. Entering service in 1969, it first saw combat in Afghanistan and quickly became prominent in the wars in the Middle East and sub-Saharan Africa. It even saw combat in Central America with the Sandinistas of Nicaragua and played a prominent role in the fighting in Chechnya.

The Mi-14 is unique among Mil helicopters in being a large, amphibious, land-based ASW helicopter. From 1976 to 1992, the Soviet, Bulgarian, and Polish navies received 270 examples, many of which remain in service.

Mikhail Mil died on 31 January 1970 and was succeeded first by Marat Tishchenko, who designed the Mi-24, and in 1992 by Mark Vineberg. In the post–Cold War period, Mil continues to design and sell military helicopters but also emphasizes a new line of helicopters intended for civilian use.

George M. Mellinger

See also
Kamov Helicopters

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Milch, Erhard (1892–1972)

The individual most responsible for the rapid formation, organization, and growth of the German Luftwaffe. Milch joined the German army in 1910, became an air observer in 1915, and ended World War I in command of a fighter wing. He joined the Lufthansa airline in 1920 and became its director in 1926. By 1933, when he joined the still-secret Luftwaffe as a colonel at the urging of his friend Hermann Goering, Lufthansa was the world's most successful airline. Milch next applied his energy to the organization of the new air force, with the full approval of Goering, who was preoccupied with his many other duties and the ongoing political intrigue within the Third Reich. Milch became Goering's deputy and the state secretary of the RLM (Germany's air ministry). He rose steadily in rank and was named a field marshal at the conclusion of the 1940 French campaign.

After the Battle of Britain, Goering devoted little time to the Luftwaffe, leaving executive control in Milch's hands. By 1943, Milch had added inspector general and director of air armament to his other titles. But his ambition to replace Goering as commander in chief became known, and Goering succeeded in taking away many of his responsibilities. In May 1944, Hitler accused Milch of deceiving him with respect to the Me 262 program and canceled a directive naming Milch as Goering's successor. Milch then withdrew into semiretirement at his hunting lodge and, in January 1945, was stripped of his last position and placed in the Führer Reserve.

In 1947, Milch was convicted of war crimes at the Nuremberg trials and sentenced to life imprisonment. His sentence was later reduced to 15 years, and he was released in 1955. He was employed as an adviser by several German industrial firms until shortly before his death in 1972.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Miles Aircraft

British aircraft manufacturer. Frederick G. Miles and George H. Miles helped form Southern Aircraft in 1925 for the purpose of rebuilding old airplanes. They designed and built the Martlet, a single-seat aerobatic biplane, in 1928–1929, selling five. In August 1932, Miles formed a partnership with Phillips and Powis. Their first design was the M.2 Hawk, a two-seat, open-cockpit, low-wing, single-engine monoplane intended as a successor to the de Havilland Moth for training and sport aviation, which flew in March 1933. This was succeeded by a side-by-side cabin-cockpit version, the M.3 Falcon, which evolved into the M.7 Nighthawk, the M.11 Whitney Straight, the M.16 Mentor, and the M.17 Monarch (1938), all seating two to four; the latter two models had limited production for use as navigational trainers.

The all-wood Magister primary trainer was a militarized and improved version of the Hawk and went into service in

October 1937. The Magister was used for all primary flight training in the RAF well into World War II; 1,293 were built. In 1936, Phillips and Powis Aircraft was bought by Rolls-Royce for the purpose of building a Kestrel-powered all-wood trainer, called the Miles M.9 "Kestrel" and Miles R.R. "Trainer," which flew in May 1937. The British Air Ministry ordered this design as an advanced trainer, which was in production from 1938 to 1942, with 3,450 being built.

In 1941, F. G. Miles bought Phillips and Powis Aircraft from Rolls-Royce and in 1943 renamed it Miles Aircraft. The M.28 Mercury prototype (put into production as the M.38 Messenger) was a twin-engine, cabin-cockpit, four-place, light, low-wing transport-trainer that flew in September 1942. The M.65 Gemini was a further improvement in this line; 250 M.38/M.65s were built.

Miles airplanes were prominent in air races in the 1930s and 1940s, and Miles had a reputation for aggressive and rapid experimental design. Miles proposed in 1936 and 1938 a blended-wing four-engine transport, the M.26 Miles-X. In 1941, Miles built a twin-engine scaled version of the X, the M.30 X-Minor, to demonstrate this design, which flew in February 1942. Two tandem-wing aircraft, the M.35 and M.39, flew as demonstrators in 1943. They were named "Libellulas" (Dragonflies), the M.35 being a single-engine pusher, the M.39, a twin-engine tractor.

In 1943, in spite of having no previous high-speed experience, Miles was asked to design and build Britain's first supersonic aircraft, the M.52, with the goal of reaching 1,000 mph, to be powered by the Whittle W.2/700 engine with afterburning. Miles made great strides, designing and wind tunnel–testing the optimum fuselage and designing and flight-testing a thin supersonic biconvex-airfoil wing. A mockup had been built when this program was canceled in February 1946, about six months before first flight, on the basis that its objectives were no longer needed. Data was given to Bell Aircraft for use in the design of the XS-1.

Miles continued to develop advanced aircraft, including the M.33 Monitor, a World War II twin-engine target-tow monoplane of 360-mph maximum speed; the M.57 Aerovan, a twin-powered, high-wing, pod-and-boom light transport of 120 mph maximum speed, that flew in 1946, with 48 being built; and the M.60 Marathon, a four-engine feeder liner that flew in 1946, with 42 being built. In 1947, Miles Aircraft was merged into Handley Page. Both F. G. and G. H. Miles continued design work on aircraft, associating with Airspeed, Hurel-Dubois, Beagle, and flight simulators (Link-Miles).

Douglas G. Culy

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Missiles, Air-to-Air and Air-to-Surface

Though widely used, air-to-air missiles (AAMs) have not yet replaced the gun as the primary air-to-air weapon. To establish and compare performance of various AAMs, a "launch envelope" is used to show minimum and maximum range against an aspect angle within which the missile can engage a target. The shape and size of the envelope will vary dramatically with target speed, altitude, and G-force as well as the firing aircraft's speed and altitude. For example, the maximum aerodynamic range at low altitude could easily be one-third of that at high altitude, and any maneuver by the target will collapse the envelope inward. A common failure is firing within the nonmaneuvering envelope; the target sees the missile and maneuvers to place the missile outside the maneuvering launch envelope. The missile then passes the target outside lethal range.

Infrared guidance is the technology of choice for small dogfight missiles (U.S. AIM-9 Sidewinder, Soviet AA-2 Atoll). The seeker homes onto the heat energy emitted by the target aircraft. The early generation of seekers operated in the 2–3 micron range and could home onto only the hot jet exhaust, but later seekers operate at longer wavelengths and can home onto the cooler parts of the target from the front. State-of-the-art seekers use imaging technology to select the precise point of impact.

Some early missiles (Fairey Fireflash, Raytheon Sparrow I, AA-1 Alkali) used beam-riding guidance. The fighter's radar emits a narrow beam that the pilot lines up on the target, and the missile steers toward the center of the beam. The first guided missile to enter operational service (the Hughes AIM-4 Falcon) used semiactive radar-homing (SARH). The fighter's radar locks onto the target and illuminates it; the seeker then homes onto the reflected emissions. Although SARH is inherently less accurate than infrared homing, the guidance laws used by the missile autopilot can be more sophisticated if the seeker is able to measure target closure rate.

A few of the larger AAMs use active radar guidance (Hughes AIM-54 Phoenix). The missile carries its own radar transmitter and homes onto the radar energy reflected off the target. Active radar guidance is now becoming practical for more moderately sized missiles (Hughes AIM-120 AMRAAM) and can be more accurate than SARH because range information is available to the autopilot.

The most influential missile ever is probably the AIM-9 Sidewinder infrared (heat-seeking) missile, originally devel-

U.S. Air-to-Air Missiles Since 1956

Year	*Name*	*Weight*	*Length*	*Range*	*Max. Speed*	*Capability*
1956	AIM-9B Sidewinder	155 lbs	9 ft, 3 in	2 miles	M=2.5	Narrow rear
1961	AA-2 Atoll	154 lbs	9 ft, 2 in	2 miles	M=2.5	Narrow rear
1963	AIM-4D Falcon	134 lbs	6 ft, 8 in	2 miles	M=4.0	Rear
1964	Red Top	330 lbs	10 ft, 10 in	7.5 miles	M=3.2	Limited all-aspect
1966	AIM-9D Sidewinder	195 lbs	9 ft, 5 in	5 miles	M=2.5	Rear
1975	Matra R550 Magic 1	198 lbs	9 ft, 1 in	1.9 miles	M=3.0	Rear
1977	AIM-9L Sidewinder	190 lbs	9 ft, 5 in	5 miles	M=2.5	All-aspect
1986	AA-11 Archer	232 lbs	9 ft, 6 in	4.6 miles	M=3.0 (est.)	All-aspect

oped by a small team operating on an equally small budget at the Naval Ordnance Test Station at China Lake, California. The AIM-9B achieved initial operational capability (IOC) in 1956 and was used in combat in 1958 by Nationalist Chinese F-86s. The U.S. Air Force employed the AIM-9B and AIM-9E in Vietnam, but they had problems at low level, in bad weather, or against maneuvering targets; the kill probability was a disappointing 15 percent. The AIM-9D was much better, and the later all-aspect AIM-9L achieved a kill probability of around 75 percent during the Falkland Islands War in 1982. The AA-2 Atoll (K-13A) bears a striking resemblance to the AIM-9B and is generally believed to be a copy. It has a similar performance to the AIM-9B and started to be replaced by the AA-8 Aphid from about 1976. The Hughes AIM-4D was also used in Vietnam, but it had serious operational problems requiring a complicated switching sequence to use; once armed, it had to be fired within two minutes.

One of the first missiles claimed to have an all-aspect homing capability was the de Havilland Red Top, which entered service in 1964. It was capable of homing onto a hot airframe from head-on if the target was supersonic.

The Matra R550 Magic 1, introduced in 1975, is the only European missile to compete with the Sidewinder family in the export market and is plug-in compatible with it. The later (1984) Magic 2 is an all-aspect weapon.

Probably the best infrared AAM in service today is the AA-11 (Vympel R-73) Archer. It is much better than the AIM-9M in acquisition, speed, electronic counter-countermeasures, and maneuverability.

Radar-guided missiles are another important variety. The world's first air-to-air guided missile to enter operational service was the Hughes AIM-4 Falcon, reaching IOC in mid-1956. Compared with its contemporaries, the radar-guided Falcon was a very effective weapon and was developed into multiple versions and exported widely, although the requirement for six missiles to fit within the internal missile bay of the F-102 interceptor meant that there was no room for a proximity fuse, and the warhead had to be very small.

The Fairey Fireflash was a beam-rider, the first air-to-air guided weapon to be deployed by the United Kingdom (August 1957). Operational trials discovered that the missile was effective against large cooperative targets, but it was too difficult for the average squadron pilot to use against maneuvering targets. It had a maximum speed of Mach 2 and could be fired at the rear of a target from a range of about 2 miles.

The first Russian missile to enter service was the AA-1 Alkali, probably in 1958. It had a range of about 3 miles. Guidance was achieved by riding a radar beam, and it was similar to the Fireflash in general performance and is likely to have shared many of the same problems.

The Raytheon AIM-7 Sparrow III was a semiactive radar-homer, with a range of about 25 miles. Used operationally by the United States during the Vietnam War, its performance was relatively poor because rules of engagement usually specified visual contact with the target. Only under unusual tactical circumstances was it employed in beyond-visual-range combat. A variant of the Sparrow, the British Aerospace Skyflash, used a monopulse seeker and demonstrated a remarkable performance during flight trials in 1975. There is some evidence to suggest that the accuracy of the later AIM-7M (used in the 1991 Gulf War) is comparable with tthat of he Skyflash.

The tactical limitations of SARH are that the fighter's radar must continue to illuminate the target until the missile hits, and only one target can be engaged at once. These restrictions are eliminated if the missile can illuminate the target using its own radar transmitter. The first active radar AAM to enter service was the Hughes AIM-54 Phoenix in 1974, with a range of about 115 miles.

Air-to-surface missiles (ASMs) have replaced bombs as the major airborne offensive weapon, particularly against heavily defended targets. The first air-launched guided missiles were built under programs managed by Siemens-Schuckert in Germany during World War I. Several missiles were tested; all were standoff glide weapons launched from aircraft or airships against shipping. The missiles were steered by commands sent through thin copper wires and were designed to split open near the target and deposit an airborne torpedo into the water. The Henschel Hs 293 became operational in summer 1943 and was probably the first successful modern ASM, with a range of about 18 miles. The missile was initially boosted ahead of the launch aircraft so that the operator could see the tracking flare, and it was guided onto the target using a two-axis joystick. Early versions were wire-guided, but a radio link was also used. The Hs 293 was used mainly in the Mediterranean Theater. The Hs 293D was probably the first missile to be television-guided, and about 70 test-firings were made before the end of World War II.

The U.S. Navy's Bat was the first antiship missile to use radar-homing; it was developed by the Navy Bureau of Ordnance in partnership with MIT, carried pulsed radar in the nose, and homed automatically onto radar energy reflected from the target vessel. With a range of up to 20 miles, from May 1945 it was very effective against Japanese warships and was used against bridges in Burma.

The Hughes AGM-65 Maverick is probably the most widely deployed ASM in the Western world and can be used against hard land targets, armored vehicles, and small ships. The AGM-65A and B are video-guided and lock onto a target nominated by the pilot, onto which they home automatically using the video image. Although the AGM-65A was used successfully in clear conditions during the 1973 Yom Kippur War, there have been instances of the seeker breaking lock and missing the target. Range varies between 10 and 25 miles, depending on the launch speed and altitude. Later versions (AGM-65C and -E) were used in a close-support role, homing onto reflected laser energy from a target designated by either an airborne pod or friendly infantry. The AGM-65E was similar to the -C but had a heavy-duty warhead, an improved laser tracker, and digital processing. The AGM-65D and -F used an imaging infrared seeker to home onto the target's heat image.

Although smaller antiship missiles use some form of command guidance (Aérospatiale AS.11), larger missiles usually have active radar guidance so that the launching aircraft can stay out of range of the target's defensive systems. The first post–World War II antiship missile to use active radar homing was the Saab RB 04, which entered service in 1958; it had a range of 20 miles.

Even though antiship missiles are small, fast targets, they can still be engaged successfully by many shipborne weapons systems; this led to the development of sea skimming ASMs. Sea skimmers have a radar altimeter, and the autopilot typically lets the missile down to the sea surface in stages, finishing a few feet above the water just before impact—the exact height varies with sea state. Most sea skimmers can be fired below the target's radar horizon and have a programmed popup to acquire the target before impact. Some can also perform dogleg course changes and a terminal maneuver to help defeat defensive systems. The Aérospatiale AM.39 Exocet is a typical sea skimmer; it entered service in 1977 and was used by the Argentine navy during the Falkland Islands War. It was developed from the ship-launched MM.38 and has a range of between 31 and 44 miles. An active-radar seeker provides terminal guidance.

Most airborne antitank guided missiles (ATGMs) are fired from helicopters and share many features with the equivalent infantry weapons. All have some form of shaped-charge warhead to penetrate the armor of a main battle tank, and some have a tandem warhead with a precursor charge to defeat reactive armor. Many helicopter-launched ATGMs are command guided using wires (AT-3 Sagger, GM-Hughes TOW), although the earlier AT-2 Swatter used an infrared seeker to home onto the target's heat source.

The Rockwell AGM-114 Hellfire is a helicopter-launched heavy antiarmor weapon and achieved IOC in 1984. The first three generations of Hellfire missiles used a laser seeker, and targets had to be designated by the firing helicopter or other friendly forces. The latest version, the Longbow Hellfire, uses a millimeter-wave radar seeker to provide adverse-weather fire-and-forget capability.

Andy Blackburn

See also

BOLO; Convair F-102 Delta Dagger and F-106 Delta Dart; Defense Suppression; Gulf War; Vietnam War

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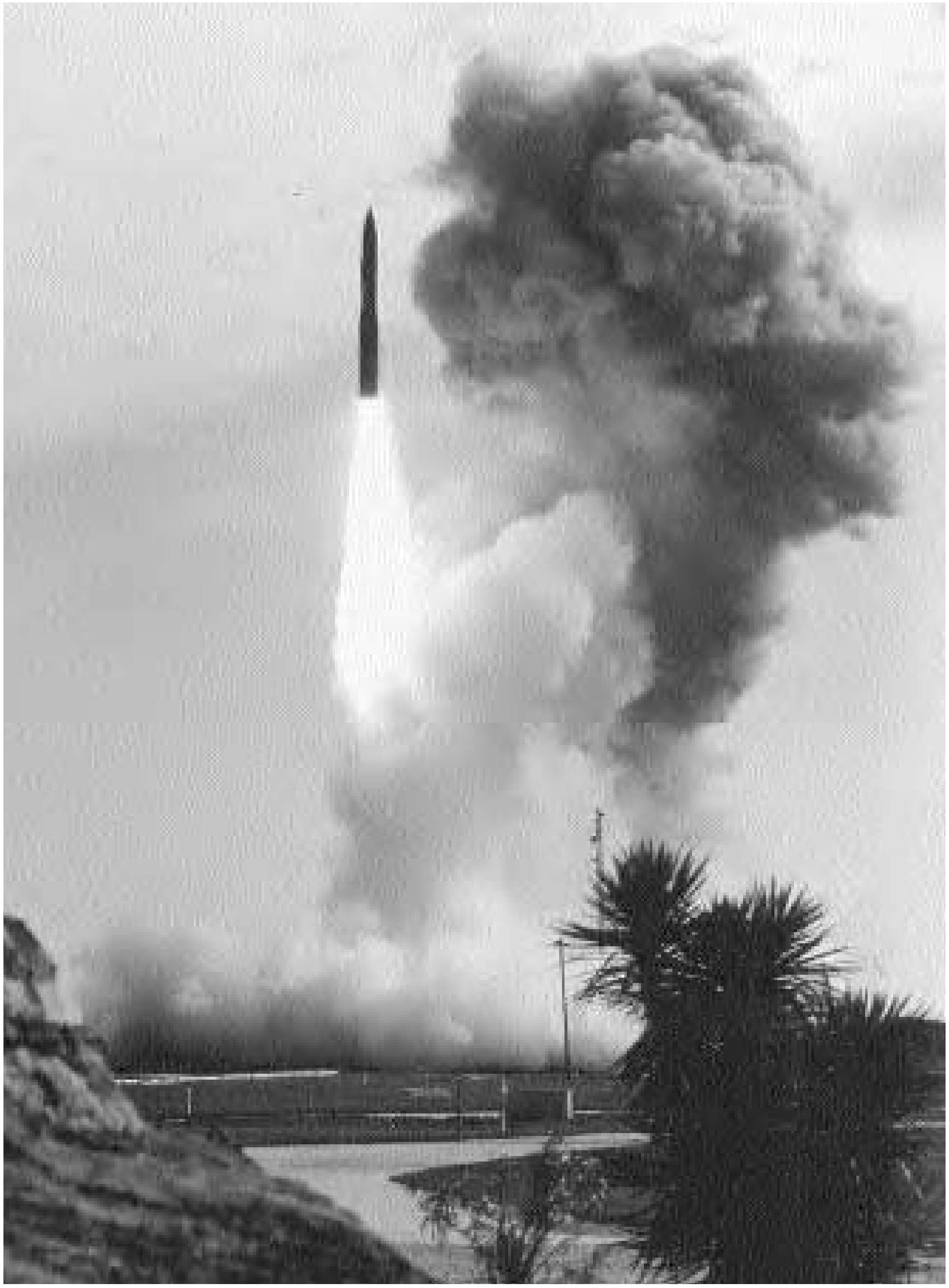
Missiles, Intercontinental Ballistic (ICBMs)

The development of ICBMs commenced in the late 1940s and early 1950s with a program authorized by Congress under the direction of the Strategic Air Command (SAC). The first ICBM prototypes, the subsonic SM-62 Snark and the supersonic Boojum proposed by Jack Northrop in 1946, had a projected range of 1,500–5,000 statute miles with a speed of 600 mph and a 2,000-pound warhead. After experiencing difficulties with the performance of the guidance systems, Northrop suggested an inertial navigation system monitored by stellar navigation. Mechanical difficulties delayed testing



Solid rocket fuel made the Minuteman missile much easier to service and to launch. (U.S. Air Force)

until the 1950s. The U.S. Air Force also considered another early missile, the Navaho, but schedule delays and difficulties resulted in the elimination of the program.

The Atlas was the first-generation ICBM developed by the Convair Division of General Dynamics Corporation between 1956 and 1963. Continued research and development resulted in the construction of Atlas SM-65A through F missiles. Atlas A reached a maximum range of 600 nautical miles and an altitude of 57.5 nautical miles. Atlas B tests improved the range to 5,500 miles in 1958. The first successful operational use of the Atlas B occurred on 18 December 1958 with the launch of the world's first communications satellite. The Atlas D became the first fully operational missile used by Strategic Air Command. Model D, stored horizontally on above-ground launchers, had a maximum range of 6,500 nautical miles propelled by liquid fuel with 360,000 pounds/thrust with a radio-inertial guidance system. Improvements resulted in the Atlas E with an increased thrust of 389,000 pounds, an all-inertial guidance system, and a large warhead. The final version of the Atlas missiles, Model F, possessed most of the same characteristics as the Model E except for an improved thrust and quicker response time due to the storability of liquid fuel. The development of Minuteman missiles resulted in a decision to phase out the Atlas missiles. Under Operation ADDED EFFORT, Strategic Air Command retired the last of the Atlas missiles on 20 April 1965.

The Titan I, classified as a first-generation ICBM, with a range of 5,500 nautical miles with a radio and all-inertial guidance system, relied on its two-stage, liquid-fueled, rocket-powered design for propulsion. Stored in hardened silos until their retirement from Strategic Air Command in 1963, the Titan I was replaced by Titan II missiles under Operation ADDED EFFORT.

The Martin Titan was the "Grand Slam" of American missiles, and served later as a booster for spacecraft. (U.S. Air Force)

Like its predecessor, the second-generation Titan II missile had an effective range of 5,500 nautical miles. Improvements over the earlier version included reliance on an all-inertial guidance system, a larger warhead, and the ability of deploying from a hardened underground silo. Ordered by SAC in October 1959, the first Titan II reached operational capability on 8 June 1963. SAC continued to operate six Titan II missile units until three accidents resulted in the death of four airmen and the destruction of two missile sites. In 1981, the Department of Defense called for a safety investigation, after which the decision to retire the Titan II missiles resulted in their removal from SAC under a program called Rivet Cap. The last Titan II went offline on 18 August 1987.

In 1958, the Department of Defense approved the development of the Minuteman I missile. Designed to withstand a first strike, this three-stage, solid-propellant, rocket-powered ICBM also had an effective range of 5,500 nautical miles. The Air Force placed the Minutemans in hardened underground silos. In 1966, a modernization program required the retirement of Minuteman I missiles, a program completed on 12 February 1969.

The Air Force integrated the Minuteman II missile (effective range of 7,000 nautical miles) into the SAC program in 1965. Engineers also incorporated an improved guidance system, an increased payload capability, and a greater ability to withstand a nuclear strike in the Minuteman II. The operational deployment of 1,000 Minuteman ICBMs completed by April 1967 formed the backbone of the SAC program until the conclusion of the SALT Treaty, at which time the remaining Minuteman II missiles were deactivated and the silos destroyed.

The Air Force deployed more than 500 Minuteman III missiles during a modernization program in 1968. Designed as a multiple independently targetable reentry vehicle (MIRV), the Minuteman III contained three Mark 12 and Mark 12A MIRVs guarded by an improved computer memory. They were stored in hardened silos, and command-and-control safeguards included an ability for airborne control if communications failure occurs between command-and-control centers. Fifty Peacekeeper missiles deployed in 1982 replaced some of the earlier Minuteman missiles. Currently, the only land-based ICBM in the U.S. nuclear arsenal, the Minuteman III, has been reconfigured to hold only one reentry vehicle in accordance with a 1992 agreement. The Air Force intends to utilize the Minuteman III missiles through 2025.

Cynthia Clark Northrup

See also

Strategic Air Command

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Missiles, Intermediate-Range Ballistic (IRBMs)

Land-based ballistic missiles, usually with nuclear/thermonuclear warheads and a range of 2,000–6,000 nautical miles. In a strategic sense, IRBMs were close to medium-

Ballistic Missiles (various countries)

Missile	*Country*	*Duration of service*	*Approximate range (miles/kms)*	*Warhead (MT)*
"Blue Steak" prototype	United Kingdom	1955–1960 project	1,512/2,800	1x3
SS-4 (Sandal)	USSR	1957–1991	1,080/2,000	1x1
SS-5 (Skean)	USSR	1961–1984	2,214/ 4,100	1x1
SS-14 (Scapegoat)	USSR	1965–not reported	2,160/4,000	no data
SS-15 (Scrooge)	USSR	Very limited deployment	3,024/5,600	no data
SS-20 (Saber)	USSR	1975–1991	2,214/5,000	3x0.15
Jupiter PGM-19A	United States	1958–1965	1,296/2,400	1x1.44
Thor SM-75	United States	1959–1964	1,296/2,700	1x1.44
Tomahawk BGM-109 GLCM	United States	1984–1990	1,555/2,880	1x0.20
Pershing II	United States	1983–1990	972/1,800	1x0.005
Dong-Feng 3/3A (CSS-2)	China	1971–	1,431/2,650	1x3
Dong Feng 4 (CSS-3)	China	1981–	2,430/4,500	1x3
S-2	France	1971–1983	1,782/3.300	1x0.12
S-30	France	1980–1998	1,890/3,500	1x1
Agni-2	India	developing	1,242/2,300	no data
Shahab-4	Iran	developing	1,080/2,000	no data
Jeriho-2	Israel	developing	1,080/2,000	no data
Ghauri-3	Pakistan	developing	1,926/3,566	no data
CSS-2	Saudi Arabia	developing	1,458/2,700	conventional

range ballistic missiles (MRBMs; 1,000–2,000 miles) and share some characteristics of historical significance.

MRBM/IRBMs were earlier types of ballistic missiles that laid the base for further development of missile technology and contributed to the initial steps of space programs. The whole history of MRBM/IRBMs revealed the dynamic and multifaceted interplay of military, technological, geopolitical, and diplomatic factors and trends. The MRBM/IRBM class remains the only one in the nuclear arsenal that was ever eliminated.

Due to their operational characteristics, MRBM/IRBMs were to be deployed in the same theater with the presumed targets. This emphasized the geostrategic disparity between the transatlantic alliance and the Soviet bloc. That is why MRBM/IRBMs emerged as highly provocative, instrumental tools for nuclear blackmail, bargaining, and pressure. Not accidentally, MRBM/IRBMs were involved in two major crises of the Cold War: the Cuban Missile Crisis (1962) and the Euromissile Crisis (1979–1985).

Soviet IRBMs were the bulk of the nuclear threat to Western Europe since the end of the 1950s. In order to ensure the confidence of European allies through U.S. nuclear guarantees, the United States deployed IRBMs (60 Thor missiles in England and 60 Jupiter missiles, divided equally, in Italy and Turkey). These were operated respectively by the RAF and Italian and Turkish air forces with nuclear warheads under USAF control.

The military value of these missiles diminished over time due to their vulnerability in the fixed and open launch sites. Nevertheless, they played a significant role, facilitating the greater European participation in NATO nuclear affairs, and were instrumental as a bargain tool to bring about a resolution to the Cuban Missile Crisis.

The arms-control limitations on ICBMs in the 1970s underlined the value of IRBMs in the strategic balance. The Soviet IRBM modernization (deployment of 800 SS-20s by 1988, capable of striking more precisely and deeply in Western Europe) challenged the transatlantic security link and ignited the second major missile crisis. Thanks to the endorsement of European allies and despite pacifist protests, NATO managed to deploy 464 Tomahawks in the United Kingdom, Germany, Italy, Belgium, and the Netherlands, as well as 108 Pershing IIs in Germany.

The new U.S. missiles, with superior operational characteristics, changed the balance in the field and placed a wide range of Soviet command, control, and communications targets under effective threat. Moscow and its allies were forced to concede. Under the 1987 Intermediate Nuclear Forces Treaty, all Soviet and U.S. MRBM/IRBMs were eliminated. Today some countries (Iran, Iraq, North Korea, Libya, and others) are trying to upgrade their ballistic missiles to the intermediate-range level.

Peter Rainow

See also

Cuban Missile Crisis; French Missile Production and Development; Missiles, Intercontinental Ballistic; Missiles; Multiple Independently Targetable Reentry Vehicle; Strategic Arms Limitation Talks; Strategic Arms Reduction Talks

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Missiles, Surface-to-Air

The first surface-to-air missiles (SAMs) were a byproduct of the German V-2 program. The Wasserfall (Waterfall) was a scaled-down version of the V-2 with a 200-pound warhead that utilized visual tracking and radio control to engage its target.

Strategic SAMs During the Cold War

The Wasserfall design led directly to the first Soviet SAM, the R-101, which was essentially a copy of the German system. Further improvements to the R-101 led to the R-113 (NATO designation SA-1 Guild). The SA-1 was the first SAM to effectively employ radars for onsite acquisition and fire control. Large numbers of the systems were deployed in a ring around Moscow beginning in 1954, but none was ever deployed elsewhere. The system remained in service until the mid-1980s, when it was replaced by more modern systems.

U.S. efforts reached fruition with the 1954 deployment of the first Nike-Ajax battalion. The Nike-Ajax was similar in performance to the SA-1 and was also deployed to protect key cities from strategic bombers carrying nuclear weapons. Approximately 300 permanent Nike sites were eventually deployed, with an upgrade already under way. The upgrade, the Hercules, extended range to more than over 75 nautical miles and increased the maximum altitude to more than 150,000 feet. The Nike system was exported to many U.S. allies during the Cold War but remains in operation in only Turkey and South Korea.

In the Soviet Union, the entirely new SA-2 Guideline utilized Fansong fire-control radar (range: 16 nautical miles; altitude 72,000 feet, with upgrades extending those numbers). The first command-guided SA-2s reached operational status in 1955 and by 1960 had claimed their first kill, a U-2 flown by Gary Powers. By mid-1965, the system had been deployed to Vietnam, where it gained fame by bringing down significant numbers of U.S. aircraft. Eventually, the SA-2 was deployed to many of Russia's allies, where it is still in service today. In fact, many countries have opted to upgrade their existing SA-2s with modern electronics and other enhancements as opposed to purchasing new systems. As a result, the half-century-old system remains a potent threat.

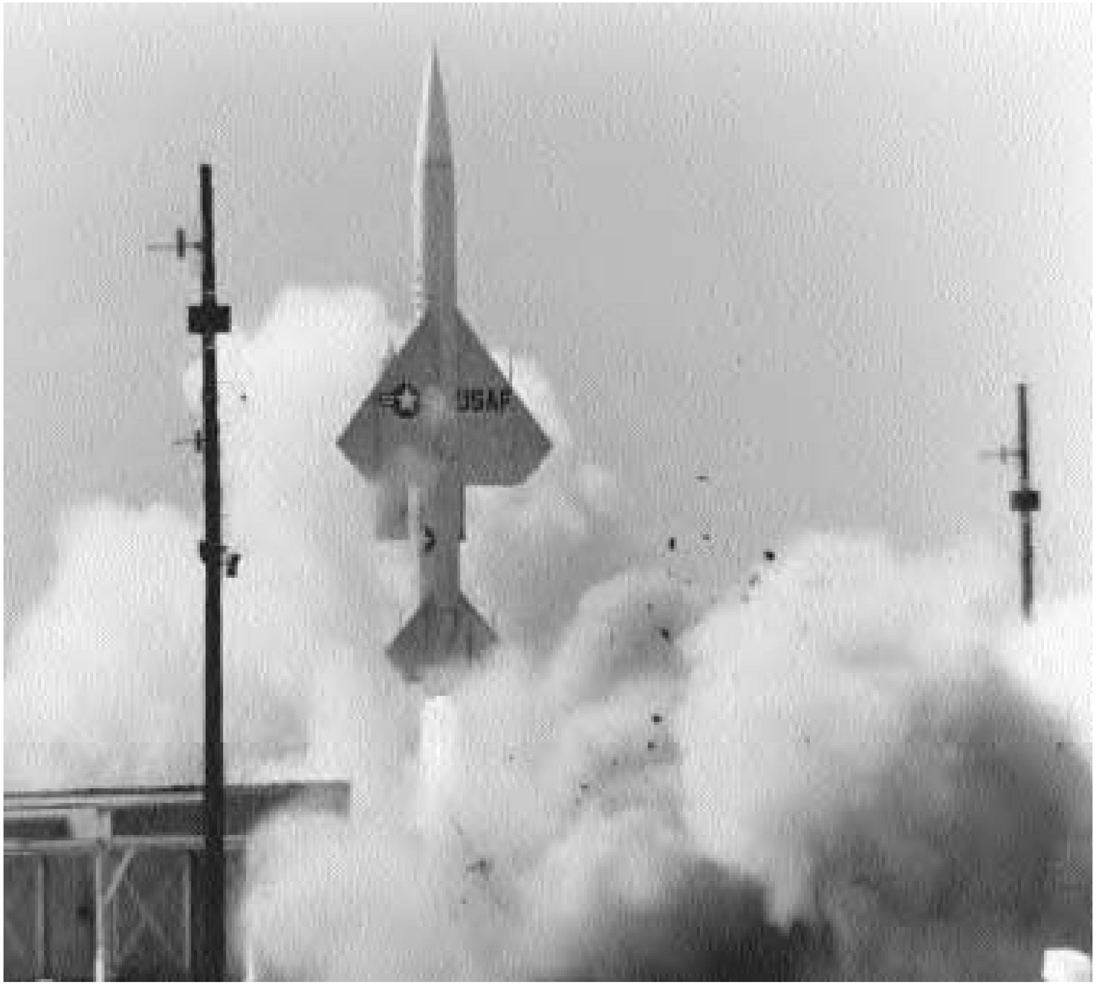
The need to protect against fast, maneuverable attackers led to the development of the SA-3 Goa in 1956, the inner layer of the Soviet defense umbrella, with the system reaching operational status in 1961. Like the SA-2, the SA-3 has been very successful in the export market. It has seen combat in every Middle Eastern conflict since 1970. In the 1990s, the SA-3 attempted to defend Serbia's airspace against NATO's Operation ALLIED FORCE with limited success.

The outermost layer of the Soviet Union's strategic air defense umbrella was the S-200 Angara (NATO designation SA-5 Gammon). Upon becoming operational in 1966, the system provided a quantum leap in the ability to engage strategic bombers and support assets before they could get close enough to become a threat. The SA-5 system combined an extremely long-range missile with sophisticated radars. The system utilizes the exceptionally powerful Square Pair radar to track targets and guide the missile. At its peak, the system was deployed in the Soviet Union at nearly 130 launch sites.

In 1967, work was begun on the system that would eventually become the S-300 (SA-10). The goal of the project was to develop a SAM with advanced capabilities to replace the obsolete SA-1 in the defense of Moscow. The system has seen constant updating. It uses the track-via-missile guidance technique, whereby the missile is simply command-guided until onboard sensors detect the target.

The United States did not develop a follow-on to the Nike until the modern Patriot system. Although work on the program was initiated in 1961, the U.S. Army was not able to deploy the system until 1982. The Patriot was designed as a mobile, all-weather air defense system providing long-range protection of key targets. The core of the system is the advanced planar phased-array AN/MPQ-53 radar, which is capable of tracking approximately 100 targets while guiding up to nine missiles utilizing the track-via-missile guidance technique. The Patriot has seen continuous improvement in computer technology, electronic countermeasures, radar versatility, and missile range. Patriot batteries gained fame by effectively countering Iraqi Scud attacks during the Gulf War. Several U.S. allies employ variants of the Patriot system, including Israel, Kuwait, and Saudi Arabia. Recent trends indicate that further deployments of the system are likely.

Russia's Almaz Central Design Bureau is hard at work on the next generation of strategic SAMs. For the Russians, the future lies with the S-400, designed to counter current and



The Boeing Bomarc was an extraordinarily sophisticated surface-to-air missile, designed to intercept incoming Soviet bombers. (U.S. Air Force)

future threats. It will employ several missile types to engage a variety of targets. As new threats emerge, so do new countermeasures; the cycle of improvement will inevitably continue.

Tactical SAMs

Tactical SAMs, along with mobile antiaircraft artillery (AAA), have a major role in defending ground personnel. Tactical SAMs can primarily be found in either a man-portable or vehicle-mounted configuration.

The first modern man-portable air defense system (MANPADS) was the U.S. Redeye, which became operational in 1964. This missile utilized an infrared (IR) homing system to lock onto an aircraft's exhaust. The Stinger replacement entered service in early 1981, utilizing a cooled-IR seeker that allowed ground troops to engage approaching targets rather than waiting until after they had been attacked and the aircraft was leaving the area. Like most other U.S. systems, the Stinger has seen constant improvement, primarily on the seeker head, making it more sensitive and more capable to reject IR countermeasures.

Tens of thousands of Stingers have been produced over the years, used by nearly 30 countries. In addition to the man-portable version, Stinger missiles have also been mounted on several ground vehicles and helicopters.

The first Russian MANPADS entered service in 1966. The SA-7, as it is known by NATO, was capable of engaging targets from directly behind the exhaust stream. Improvements were made to allow target acquisition up to 30 degrees on either side of the exhaust plume. In 1974, the SA-14 was brought into operational service, the first Soviet MANPADS to utilize a cooled-IR seeker. In addition to allowing forward-hemisphere engagements, the cooled-IR technology also greatly reduced the seeker's vulnerability to IR countermeasures. The SA-16 and SA-18 entered service in the early 1980s and featured improved resistance to IR countermeasures. The SA-18 can effectively discern even the most advanced countermeasures, such as pyrotechnical, blinking, and modulated IR decoys. It has the greatest range of any of the systems. All of these MANPADS have been produced in great quantities.

The only tactical SAMs produced by the United States that are not man-portable are the Raytheon MIM-23 HAWK (Homing All the Way Killer) and the Chaparral. Work began on the HAWK in 1952, and the system became operational in 1960. The HAWK was designed as a mobile, low-to-medium-altitude SAM intended to protect front-line ground forces from air attack. The system is mounted on trailers and is the exception to the vehicle-mounted trend. The missile utilizes semiactive radar-homing for guidance (the missile uses radar energy reflected off the aircraft to home onto the target). The radar providing the signal is a high-power illuminator, the fire-control radar for the HAWK system. After many upgrades, the HAWK is still in service in U.S. forces and has been a successful export.

The Chaparral was originally designed to provide close air support of field targets. Like many of the MANPADS, the system utilizes an IR seeker to engage targets out to a maximum range approaching 5 nautical miles. However, the system can lock onto many targets at nearly twice this range. Although phased out of the U.S. inventory, the system is still employed by a handful of countries.

The Soviet Union began working on vehicle-mounted tactical SAMs in 1958. The program led to the SA-4 Ganef, which entered service in 1967. The system is usually deployed 6–15 miles from the front. Very few remain in service today.

The second tactical SAM developed by the Soviets was the very successful SA-6 Gainful, which Bosnian Serbs used to down a USAF F-16 in 1995. The SA-6s are mounted on one tracked vehicle while the Straight Flush radar is mounted on another. Once the radars are activated and a missile launched, the round will home onto the reflected energy out to its maximum range and altitude.

A Soviet joint army-navy project was the SA-8 Gecko, in which both the missiles and radar would reside on the same chassis. Entering service in 1972, the six-wheeled all-terrain vehicle was able to move just behind the forward line of troops. The system was able to protect the troops within a radius of 5 nautical miles up to an altitude of 16,000 feet and has been exported to several countries, seeing combat in both the Middle East and Africa.

The SA-11 first entered service in 1979–1980. It is a tracked vehicle with four ready-to-launch Gadfly missiles located on the same chassis and designed to provide direct cover to the forward echelon of forces. The vehicle contains an additional four missiles that can be launched off the dual-role loader/launcher.

The most advanced Russian tactical SAM is the S-300V (SA-12 to NATO). The system's two missiles are known as the Gladiator and the Giant. Typically, an SA-12 battery will be a mix of both missile types, with the Gladiator engaging maneuvering targets, cruise missiles, and tactical ballistic missiles (TBMs) while the Giant concentrates on long-range aircraft and longer-range TBMs.

Probably the most advanced low-altitude tactical SAM is the SA-15 Gauntlet. This system, known in Russia as the Tor, was developed during the 1980s as a replacement for the SA-8. It was designed to defend against highly maneuverable aircraft, helicopters, precision-guided munitions, cruise missiles, and remotely piloted vehicles. The system comes mounted on either a tracked or wheeled vehicle, the wheeled version primarily intended for export. Mounted on the chassis are all the components required to make each vehicle an autonomous air defense cell. The system is slowly replacing the SA-8 in the Russian inventory and has been exported to a few countries.

The latest Russian radar-guided tactical SAM is the SA-17 Grizzly, designed to engage basically the same target set as the SA-15, only at a longer range (27 nautical miles) and higher altitude (82,000 feet) The system is in limited production and is being employed the Russian army. There are no known exports of the system.

The Russians also developed several vehicle-mounted IR systems. The first of these, the SA-9, was developed in the late 1960s and entered service in 1968. This system consisted of four IR missiles mounted on a BRDM-2 all-terrain reconnaissance vehicle. The system was replaced by the SA-13 in 1975, incorporating IR counter-countermeasures and allowing for all-aspect engagements. Both the SA-9 and the SA-13 have been successful on the export market and have seen combat in locations ranging from Africa to the Balkans.

The final tactical system is a hybrid gun-missile system known as the 2S6 Tunguska that was developed in 1970 as a follow-on to the ZSU-23-4 self-propelled AAA piece. The system first entered service in 1986 and was designed to fill the gap between the MANPADS and the SA-15. The Tunguska combines four 30mm cannons with eight command-guided SA-19 missiles. The missiles can engage fast maneuverable targets. The Hot Shot fire-control radar is mounted on the rear of the vehicle and provides the critical information required to engage with either the guns or the missiles. Additionally, the system is equipped with optical sites, which can be used to prosecute engagements with both weapons as well. The decision as to which weapon to use is left to the battery commander. The system is in service with Russian forces and has been exported to India as a replacement for their ZSU-23-4 guns.

As long as there is a credible air threat to troops on the ground, there will be a requirement for tactical SAMs.

Troy D. Hammon

See also
Defense Suppression; DESERT SHIELD; DESERT STORM; German Rocket Development; Missiles, Surface-to-Air; Wild Weasel; Yom Kippur War

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Mitchell, Reginald J. (1895–1937)

British aircraft designer. Born on 20 May 1895 in Talke, Staffordshire, Mitchell trained as an engineer, joined Supermarine Aviation Works in 1916, and became chief engineer and designer in 1919.

Supermarine specialized in flying-boat construction. Mitchell produced a series of successful flying boats with wooden monocoque hulls for both military and civil use, including the Southampton and the Sea Lion, which won the Schneider Trophy in 1922.

Mitchell, however, was an early proponent of all-metal structure. In 1926, he designed a successful light-alloy hull for the Southampton that was stronger and lighter by some 900 pounds. A series of military and airliner boats followed that also attracted export orders.

Fame came Mitchell's way for his series of specialized racing seaplanes that competed for the Schneider Trophy. The unsuccessful wooden S.4 of 1925 was followed by the S.5, with a duraluminium monocoque fuselage, which won the 1927 contest. The all-metal S.6 won in 1929, and its developed successor, the S.6B, in 1931 gave the Schneider Trophy permanently to Britain.

Mitchell's experience with streamlining and monocoque structures led directly to high-speed fighter designs. The clumsy Type 224 was followed by the Spitfire in 1936. This design combined an elliptical wing planform to minimize drag with the powerful Merlin engine and a slender fuselage to produce the most successful British fighter of World War II. Some 22,000 Spitfires were built before production ceased in 1949. Mitchell himself did not witness this triumph; he died on 12 June 1937.

Paul E. Fontenoy

See also
Flying Boats; Supermarine Aircraft; Supermarine Spitfire

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Mitchell, William "Billy" (1879–1936)

U.S. Army Air Service brigadier general and early advocate of American airpower. Born on 29 December 1879 in Nice, France, Mitchell grew up near Milwaukee, Wisconsin. He enlisted in the Army while attending George Washington University at the outbreak of the Spanish-American War in 1898. He became a Signal Corps officer and served in the Philippines. Afterward, he supervised the erection of a 1,700-mile telegraph line in Alaska. In 1905–1906, Mitchell was an assistant to the commandant of the Signal School at Fort Leavenworth, Kansas, where he developed a forward-looking lecture on military balloons.

After graduating from the Army Staff College, he returned to the Philippines and carried out a successful undercover reconnaissance of Japanese activities in the region. Subsequently, he served on the Army general staff until 1916, when he became deputy chief of the Aviation Section of the Signal Corps. He departed for Europe as an aeronautical observer in March 1917, weeks before the U.S. declaration of war.

In Europe, he planned the organization for the U.S. tactical air service and served as its operational commander. He presided over the largest air armada ever assembled for a specific mission at that time, during the Americans' 1918 Saint Mihiel Offensive. Upon returning to the United States, he became assistant chief of the Air Service and began his crusade for an independent air force and a unified department of defense.

Mitchell believed that airpower had made the naval battleship obsolete and substantiated his claims by sinking the German prize battleship *Ostfriesland* during an aerial bombardment test in July 1921. Mitchell publicly accused the War Department and Navy Department of incompetence and criminal negligence after the crash of the naval airship *Shenandoah* in September 1925. This led an army court-martial to convict him of insubordination.

Mitchell resigned on 1 February 1926 but continued his advocacy for airpower through numerous speaking tours, articles, and books. He died in New York City on 19 February 1936. His most famous publications include *Memoirs of World War I* (1928) and *Winged Defense* (1925), a reflection

General Billy Mitchell loved to fly, and in doing so won the respect of the men he led. (U.S. Air Force)

of his views on the military and the economic implications of aviation.

Bert Frandsen

See also

Saint Mihiel, Battle of; U.S. Army Air Service

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Mitscher, Marc Andrew (1887–1947)

U.S. admiral and naval aviation pioneer. Mitscher was born in Hillsboro, Wisconsin, on 26 January 1887 and attended the U.S. Naval Academy, graduating in 1910. He spent five years assigned to various surface ships before being accepted for flight training. One of the navy's first naval aviators, Mitscher was at the forefront of that field for the next three decades. After tours with the aviation department on a cruiser and as commander of naval air stations on Long Island and Miami, Mitscher spearheaded the Navy's first attempt at transatlantic flight as command pilot of NC-1. Though he succeeded only in reaching the Azores, Mitscher earned a Navy Cross and the admiration of his peers. He later led Navy teams to the International Air Races of 1922 and 1923.

Following duty on USS *Langley,* the Navy's first aircraft carrier, Mitscher headed the Air Department on USS *Saratoga.* He subsequently served as executive officer on both ships. Ashore, Mitscher spent several tours at the Aeronautics Bureau and accepted sea assignments in command of an aircraft tender and Patrol Wing One. When war with Japan erupted, Mitscher was the commanding officer of the Navy's newest carrier, the *Hornet.*

Transferring to the Pacific, Mitscher and his crew carried Colonel Jimmy Doolittle's bombers to within range of Japan for their historic mission (April 1942). In May, he led his ship and aircraft into the decisive Battle of Midway, contributing significantly to the sinking of four irreplaceable Japanese carriers.

Promoted to rear admiral in July 1942, Mitscher took command of Patrol Wing Two and soon commanded Fleet Air during the campaigns for Guadalcanal (December 1942) and the Solomon Islands (April 1943). Commanding the Fast Carrier Task Force that supported, alternately, Admirals William Halsey and Raymond Spruance, Mitscher was just as successful in the Marshalls, Truk, Saipan, and the Battle of the Philippine Sea (June 1944), in which his aircraft decimated the Japanese air forces in the decisive Marianas Turkey Shoot. At the Battle of Leyte Gulf (October 1944), Mitscher's forces virtually eliminated the Imperial Japanese Navy as a fighting force. Throughout 1945, Mitscher's planes hammered Iwo Jima, Okinawa, and the Japanese home islands.

At the conclusion of the war, Mitscher served briefly as deputy Chief of Naval Operations (Air). Promoted to admiral in 1946, he subsequently served as commander of the Eighth Fleet and the Atlantic Fleet. Mitscher died at sea on 3 February 1947.

Michael S. Casey

See also
Doolittle, James H.; Guadalcanal; Halsey, William F.; Iwo Jima; Leyte Gulf, Battle of; Marshall Islands; Midway, Battle of; Okinawa; Philippines Islands, campaigns in 1944; Spruance, Raymond A.; Yamamoto, Isoroku

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Mitsubishi A6M Reisen ("Zero")

Premier Japanese fighter of World War II. The Zero resulted from a navy proposal in May 1937 for a carrier aircraft to replace the Mitsubishi A5M Type 96 fighter.

A Mitsubishi design team led by Jiro Horikoshi drew upon combat reports from China to upgrade the specs. Horikoshi's team developed an all-metal, low-wing monoplane with a 780-hp Mitsubishi Zuisei engine, which first flew on 1 April 1939. Following initial tests, the two-blade propeller was replaced with a three-blade constant-speed unit, and a Nakajima NK1C Sakae 12 engine was fitted to surpass speed requirements. Production models of the A6M2 were deployed for combat in China in July 1940. With minor changes, including folding wing tips that reduced the span by 1 meter to accommodate carrier-deck elevators, the Type 0 Model 21 was manufactured at Nakajima and Mitsubishi facilities. The Zero led the attack and provided cover for Japanese bombers and torpedo-bombers at Pearl Harbor and the Philippines; Zeros ensured success in battle at Wake Island, Darwin, Ceylon, and the East Indies.

A series of variants began with the A6M3, powered by the supercharged Sakae 21 14-cylinder radial engine of 1,130 horsepower. Heavier armament, a shortened wing to eliminate the folding, fuel-tank reconfiguration, and other changes enabled the Zero to control airspace in the Pacific until May 1942. By mid-1942, captured Zeros were studied for weaknesses in performance and construction, and Allied fighter tactics were adapted accordingly.

Unable to compete with P-38s, F4Us, and F6Fs at higher altitudes, the Zero was modified in August 1943, employing a new wing design with heavier skins to increase diving speed; reworked exhaust stacks allowed more power. This A6M5, with the armament of the A6M3, could dive at speeds up to 410 mph. In early 1944, the A6M5b, even with even heavier wing skins, armored glass, fuel tank fire extinguishers, heavier armament, and a diving speed of 460 mph, failed to match the U.S. Navy F6Fs at Leyte Gulf and the Battle of the Philippines.

In late 1944, the ventral drop tank was replaced with a 250-kg bomb to be used as kamikazes, which sank the escort carrier *St. Lô* and damaged several others. Japan's defeat in the Philippines led to increased armament and use of the Nakajima Sakae 31 water/methanol-injected engine and self-sealing fuel tanks, which resulted in the A6M6c. Continued losses of carriers and aircraft and weak performance of the A6M series brought more extensive changes. Fitted with factory bombracks for use as a dive-bomber, stronger tail empennage, more armor, and wing drop tanks, the A6M7 Model 63 began production in May 1945. To deal with the increased weight, the more powerful Mitsubishi 1,560-hp Kinsei 62 engine was employed and yielded the A6M8 Type 0 Model 64 in April 1945, too late to be to produced before the war ended.

The name "Reisen" is a contraction of *rei sentoki,* (0 Fighter); Allied code names were "Zeke," "Hap," or "Hamp." The Zero, built in greater numbers than any other type of Japanese aircraft, remained Japan's first-line fighter until the end of the war. Estimates of total production figures are 10,449 of the A6M model in all variants.

Richard C. DeAngelis

See also
Horikoshi, Jiro; Mitsubishi Aircraft

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Mitsubishi Aircraft

Japanese aircraft manufacturer. The Mitsubishi industrial complex originated during Japan's period of modernization following the restoration of the Japanese Meiji emperor in

1868. By the turn of the century, Mitsubishi was a large shipbuilding and shipping company. The Mitsubishi Shipbuilding and Engineering Company, Ltd., at its Oh-e-machi plant in the southern section of the port of Nagoya, produced Renault 70-hp aircraft engines as early as 1916. The following year, France licensed the company to manufacture the Hispano-Suiza engine. Mitsubishi aircraft interests date from 1918, when Dr. Kumezo Ito went to France to study aircraft manufacture in World War I. In May 1920, the Mitsubishi Nainenki Seizo KK (Mitsubishi Internal Combustion Engine Company, Ltd.) was separated from the shipbuilding operations and began manufacturing aircraft engines at its Nagoya plant.

During these early years, Mitsubishi filled an army order for its Type Ko 1 trainer based on the Nieuport 81 design and later the Type Ki 1 after the Hanriot HD-14 trainer. Upon securing a navy contract to produce carrier-borne aircraft, an engineering team under the direction of British engineer Herbert Smith, formerly of Sopwith Aviation of Great Britain, designed and produced planes for the Imperial Japanese Navy and Imperial Japanese Army. The company became solidly established as an aircraft manufacturer, and its designs reflected the British influence for more than a decade.

The company changed its name to the Mitsubishi Kokuki KK (Mitsubishi Aircraft Company, Ltd.) on 1 May 1928 and founded an engineering branch in Tokyo as Tokyo Kikai Seisakusho (Tokyo Engineering Works). The continued growth of ship, engine, airframe, and engineering divisions led to their amalgamation in 1934 under a reorganized company named Mitsubishi Jukogyo KK (Mitsubishi Heavy Industries Company, Ltd). In the period 1935–1940 Mitsubishi continued to expand aircraft and engine manufacturing facilities at the Nagoya Aircraft Works, located at the growing Oh-e-machi complex built on a dredged landfill in Nagoya Harbor.

By 1938, Mitsubishi's continued growth and production, including its expanded facilities at Nagoya (where 14-cylinder radial air-cooled Kinsei aircraft engines were manufactured), made Mitsubishi a leading contender in aircraft production with its rival Nakajima, which was founded by the Mitsui combine and produced more total units.

The growing ambition and power of army and navy militarists sought to create an aircraft industry that could be self-sufficient and based upon Japanese-designed airframes and engines. In order to become independent of foreign sources for machine tools, in January 1939 Mitsubishi opened a special plant at Hiroshima dedicated to machine-tool production. The Japanese government sought to maintain secrecy concerning the growth of its aircraft development and production and restricted the Japanese press in referring to Mitsubishi's aircraft manufacturing activity.

By 1940, Mitsubishi operated six airframe and 11 engine plants at manufacturing sites in Nagoya and other areas. The proliferation of designs and variants resulted in Mitsubishi's growing reputation as maker of some of the finest combat airplanes of the period and as one of Japan's leading aircraft and engine manufacturers, producing military aircraft for the navy and army and civilian aircraft in separate divisions of the company.

Throughout World War II, Mitsubishi played an important role in supplying Japan's armed forces with air assets for decisive battles. The company became the most significant aircraft producer in total weight produced; it was also the largest engine producer, making 38 percent of all Japanese combat aircraft engines in World War II. Figures from the U.S. Strategic Bombing Survey suggest that Japan's aircraft production peaked in 1944 with 28,180 aircraft. Japan produced some 50,000 fighters, bombers, and reconnaissance aircraft and nearly 70,000 aircraft of all types between 1941 and 1945, of which Mitsubishi produced 23 percent; Nakajima, its largest competitor, produced 37 percent.

Despite Japan's steadfast efforts, aircraft production declined sharply after 1944 due to the combined efforts of the U.S. Navy, which destroyed Japan's merchant fleets, and the aerial assault of U.S. B-29 bombers. The achievements of Japan's aircraft manufacturers during the period 1937–1945 had the effect of disproving the prevailing view in the West that the Japanese were capable of producing only poor-performing aircraft that would be mere imitations of obsolete Western designs. Many of Japan's aircraft in the early years of World War II were of exceptional quality and were surpassed by few contemporary machines.

Richard C. DeAngelis

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Mitsubishi G4M ("Betty")

Japanese light bomber. Mitsubishi's G4M (known as the Navy Type 1 attack bomber and code-named "Betty" by the Allies) was produced in larger numbers than any other Japanese bomber. The aircraft evolved from the Mitsubishi G3M series ("Nell" to the Allies), which originated with Admiral Isoroku Yamamoto's call for its development.

In September 1937, navy specifications were issued for a

One can only wonder what thoughts were going through the minds of these young Japanese pilots as they waited beside a Mitsubishi G4M equipped with the Okha suicide weapon. (U.S. Air Force)

land-based attack bomber to replace the G3M series, to be powered by a pair of 1,000-hp engines, able to carry a crew of seven to nine men, and have a top speed of 247 mph at 9,845 feet. The plane was designed for a range of 2,993 miles without a bombload, or 2,302 miles with an 800-kilogram torpedo or bombload.

To meet this performance, the aircraft's engines were later upgraded to Mitsubishi Kasei-14, an air-cooled, 14-cylinder radial engine capable of 1,500 horsepower. The G4M aircraft was distinguished by its cigar-shaped fuselage, which facilitated crew movements and mass production.

Defensive armament included a single 7.7mm machine gun in the nose, a flexible 7.7 mm machine gun in the dorsal blister, one 7.7 mm machine gun in each of the lateral fuselage blisters behind the wing, and one hand-held 20mm canon in the tail. The prototype first flew successfully on 23 October 1939, with only minor design changes called for; production was delayed due to the immediate need for the navy carrier fighter, the Mitsubishi A6M2, to escort the G3M bombers on raids deep into China.

Production of the G4M1 Model 11 began in 1940, and in the summer of 1941 the 1st Kokutai took the G4M1s on bombing raids of Chungking (Zhongqing). Additional G4M1s served in Indochina and on Formosa, where they joined in the sinking of HMS *Prince of Wales* and HMS *Repulse* and aided in eliminating U.S. airpower in the Philippines. G4M1s operated from bases in the East Indies, New Guinea, and Solomon Islands.

The weakness of the aircraft was its lack of armor to protect crew and critical components, as well as inadequate fuel-tank protection. High losses in combat were sustained due to the tendency of the aircraft to burst into flames when hit by enemy fire, earning it the tag "Flying Lighter" from Japanese troops and Allied forces. To remedy these deficiencies, the Model 12 was fitted with more powerful Kasei-15 engines, enabling higher altitudes to escape light anti-aircraft guns. The fuselage side blisters were converted to flush panels, and rubber sheeting was added in the wing and fuselage tanks along with carbon-dioxide fire-extinguishing systems. The slightly reduced performance allowed the aircraft to sustain more battle damage, although losses remained heavy. Two G4M1s carrying Admiral Isoroku Yamamoto and his staff were shot down over Bougainville on 18 April 1943.

The later G4M2 Model 22 added yet more powerful engines, increased armaments and armor, and bomb-bay doors that were not used on the G4M1 model. In 1943, accelerated production of the G4M introduced several improved variants, but in small numbers. One version, the G4M2e, had the bomb-bay doors removed to carry the navy's suicide-pilot missile, the "Okha," however, these aircraft were heavy, had poor handling characteristics, and became easy prey for Allied fighters. Mitsubishi produced a total of 2,416 G4M aircraft of different variants, but only 60 units were of the later G4M3a introduced in January 1945. This model was powered by 1,825-hp Kasei-25 (MK4T) engines; some aircraft had minor armament changes, and some units were fitted with air-to-surface radar. The plane became known to the world on 19 August 1945 when two all-white G4M1s marked with green crosses transported Japan's surrender delegation to participate in the peace settlements of World War II.

Richard C. DeAngelis

See also
Horikoshi, Jiro; Mitsubishi Aircraft; Yamamoto, Isoruku

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Moelders, Werner (1913–1941)

One of the outstanding leaders of the Luftwaffe fighter force. Werner "Vati" (Daddy) Moelders joined the Reichswehr as an officer candidate in 1931 and in 1934 was accepted for fighter training in the still-secret Luftwaffe. He was the most successful fighter pilot in the Kondor Legion in Spain, with 14 victories, but his greatest accomplishment in Spain was in the field of fighter tactics. He is credited with developing the basic two-aircraft (*rotte,* or "element") and four-aircraft (*schwarm,* or "flight") formations and tactics that were later adopted by most of the world's air forces. During the campaign in France, he became the first fighter pilot to be awarded the Knight's Cross of the Iron Cross, for 20 post-Spain air combat victories. During the Battle of Britain, he was the first of the younger generation of fighter pilots to be given command of a wing, Jagdgeschwader 51 (JG 51; 51st Fighter Wing), and engaged in a well-publicized scoring competition with Adolf Galland.

In mid-1941, JG 51 transferred east to take part in Operation BARBAROSSA, the Nazi invasion of the Soviet Union, and Moelders continued to score at a high rate. On 15 July 1941, he claimed his 100th and 101st victories. As the first German pilot to reach such heights, he was grounded from combat flying and awarded a new combat decoration, the Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross, by Hitler. By now a colonel, he was named general of the fighter arm, a staff position within the Luftwaffe High Command. On 22 November 1941, while returning to Berlin from an inspection trip for Ernst Udet's funeral, he was killed in a plane crash due to bad weather, before he could have much effect in his new post.

Donald Caldwell

See also
German Air Force (Luftwaffe); Spanish Civil War

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Moffett, William Adger (1869–1933)

The father of naval aviation. William A. Moffett was born in Charleston, South Carolina, on 31 October 1869. After graduating from the United States Naval Academy in 1890 and subsequently receiving his commission as ensign, he served in the cruiser *Chicago,* commanded by Captain Alfred Thayer Mahan. During the Spanish-American War, Moffett served in the armored cruiser *Charleston,* participating in the capture of Guam and at the Battle of Manila Bay. Moffett also saw duty as navigation officer in the armored cruiser *Maryland* and as executive officer of the battleship *Arkansas.* He won the Congressional Medal of Honor while in command of the cruiser *Chester* during the U.S. invasion of the Mexican city of Veracruz in 1914. Moffett's service as commandant of the Great Lakes Naval Training Station during World War I provided administrative experience and exposed him to the potential of aviation.

After the war, as captain of the battleship *Mississippi,* he oversaw the fitting of turret platforms used to operate gunfire-spotting and scouting aircraft. Largely through the influence of pioneer naval aviator Henry C. Mustin, Moffett became Director of Naval Aviation in March 1921 and in July, as rear admiral, assumed the position of chief of the new Bureau of Aeronautics, where he advocated the development of the aircraft carrier and initiated a program to equip nearly all battleships and cruisers with catapults and aircraft.

Moffett became embroiled in a controversy with Army General William "Billy" Mitchell and the advocates of a unified air force. It climaxed in 1925, when Mitchell criticized the naval leadership for "criminal negligence" in the failure of a flight to Hawaii and the fatal crash of the airship *Shenandoah.* Accusing Mitchell of irresponsible demagoguery, Moffett received satisfaction when a court-martial found Mitchell guilty of insubordination and forced his resignation from the Army.

Within the Navy, Moffett waged a decade-long battle to secure authority over aviation. He wrested control over aviation personnel from the powerful Bureau of Navigation and defended flight pay as one of the perquisites of flying officers and enlisted men. Moffett brought aircraft and engine procurement under the authority of the Bureau of Aeronautics and worked out a flexible system combining negotiated and competitive contracts for aircraft, engines, and equipment. His greatest accomplishment was 1926 legislation providing for the acquisition of 1,600 naval aircraft over 5 years.

He was less successful in the development of the small aircraft carrier and the flying-deck cruiser, a hybrid warship combining elements of the scout cruiser and aircraft carrier. Neither did the rigid airship prove to be a solution to the Navy's problem of reconnaissance in the Pacific. Neither *Akron,* completed in 1931, nor *Macon,* commissioned two years later, realized its potential in limited operations with the fleet. Ironically, Moffett died when *Akron* went down in a storm off the New Jersey coast on 4 April 1933.

A visionary and master of the art of compromise and public relations, Moffett understood that political activism was essential to meet the technological, bureaucratic, and economic challenges facing naval aviation. His energy and foresight created the foundation for what became the most powerful and efficient naval air arm in the world.

William F. Trimble

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Morane-Saulnier 406

The mainstay of the French air force at the beginning of World War II. The Morane-Saulnier MS 406 fighter, despite limited speed and armament, represented a new phase in French military aircraft development. The prototype 406 C1 flew for the first time on 20 May 1938.

The MS 406 marked an important change in French production methods from quasi-artisan style to conventional mass assembly. Unfortunately, the time required to produce an MS 406 was almost double that of the 8,000 hours required to build its German competitor, the Messerschmitt Bf 109. By December 1939, factory output was some 40 percent behind schedule, a problem accentuated by the delay in the production of the engine, the Hispano-Suiza 12Y of 860 horsepower.

Despite such production troubles, some 1,084 machines were produced. The MS 406 found a small export market in Turkey and Finland. After purchasing two French-built MS 406 C1s for evaluation, the Swiss Aircraft Factory manufactured a total of 74 machines under license, redesignating them as the D-3800; another 190, with heavy modifications by Swiss engineers, were redesignated the D-3801.

The MS 406, alongside the Curtiss H 75, became the main opponent of Luftwaffe fighters in the Phony War (September 1939–May 1940). It was the first French fighter to exceed 400 kph; training versions, the MS 430 and MS 435, were also developed. The fall of France, however, cut short the aircraft's career, although many continued to fly in French colonies as well as the Vichy and Free French air forces; a few were used by the Axis.

Guillaume de Syon

See also

French Aircraft Development and Production (World War I–Early World War II); Vichy French Air Force

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Morane-Saulnier Aircraft

French aircraft manufacturer during World War I. Morane-Saulnier was already a major part of the Aviation Militaire (French air force) when World War I began, the company's aircraft making up a significant portion of the strength of French escadrilles. However, the firm's first real mark in military aviation history began to take shape during the war's first winter when Raymond Saulnier collaborated with aviator Roland Garros on the design of a pair of steel wedges that would be fitted to the propeller of a Morane-Saulnier Type L parasol monoplane, allowing a machine gun to be fired through the propeller without damaging it. Garros tested the device the following spring with promising results, achieving three victories before falling prisoner behind enemy lines. Later that year, the great Georges Guynemer scored the first of 53 victories flying a Morane.

The Morane-Saulnier L continued to equip two-seater escadrilles doing reconnaissance and artillery regulation until gradually replaced by the Nieuport. But because the L had shown early promise as a fighter, Morane turned to the development of another monoplane, this one a shoulder-wing design known as the Bullet. The Bullet, like its parasol-winged stablemate, was rotary-powered; also like the L, it sported a Hotchkiss machine gun fixed in front of the pilot, steel wedges protecting the propeller from its fire. Unfortunately the Bullet, like the Parasol, also fell victim to competition from Nieuport, although it was the Type 11 Bébé that did in the latter Morane.

Morane-Saulnier also manufactured biplane designs during World War I, but none that achieved much fame or was built in large numbers. Its next, and last, wartime success came in the A-1, another parasol monoplane, which equipped a handful of fighter escadrilles toward the war's end. Wing failure led to the A-1's replacement.

James Streckfuss

See also
Garros, Roland

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Mu Gia Pass

Site of U.S. interdiction campaign during the Vietnam War. On 30 September 1964, the U.S. Joint Chiefs of Staff implemented plans for cross-border air operations in Laos, including attacks on Mu Gia Pass. The objective was to stop the infiltration of enemy troops who, after leaving Mu Gia Pass, crossed over into Laos and made their way down the Ho Chi Minh Trail. A newly formed South East Asia group expressed unanimous agreement that U.S. participation in air strikes was essential if such operations were to have the desired military and psychological impact. The interdiction program of air strikes began on 14 October 1964. By 1966, more than 5,000 B-52 sorties had been flown to bomb the approach to Mu Gia Pass in Vietnam. The bombing campaign sometimes slowed but never halted the passage of troops through the pass and down the trail.

Albert Atkins

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Muencheberg, Joachim (1918–1943)

Outstanding German fighter pilot and combat commander of Jagdgeschwader 26 (JG 26), considered to be the Luftwaffe's best fighter wing while under his leadership. A professional officer in the prewar Luftwaffe, Joachim "Jochen" Muencheberg was successful in the French campaign and in the Battle of Britain; he was awarded the Knight's Cross of the Iron Cross for 20 air combat victories. The squadron he led, Staffel 7/JG 26, was sent to Sicily in early 1941 as an independent command and given the mission of winning air superiority over Malta. Amazingly, this unit of 12 Messerschmitt fighters was totally successful in this daunting task, destroying Malta as an offensive base and causing the British to revise their strategy for the entire Mediterranean Theater of Operations. Staffel 7 spent six months in the theater, based in Sicily, Greece, and Libya, and was credited with 52 air victories without losing a single pilot, a record arguably unmatched by any squadron-sized formation in history when facing an opponent of nominally equal ability.

Upon his return to France, Muencheberg was given command of the 2d Group of JG 26 and led it from Abbeville during the period of the Luftwaffe's greatest ascendancy over RAF Fighter Command, whose respectful pilots called Muencheberg's group "The Abbeville Boys," a nickname that Western Allies would come to apply to any especially aggressive Luftwaffe fighter formation.

In mid-1942, Muencheberg was ordered to the Eastern Front to fill in for a wounded wing leader. He soon scored his 100th air victory, for which he was awarded the Oak Leaves with Swords to the Knight's Cross of the Iron Cross and promoted to major. He was given permanent command of JG 77 and led it to North Africa in October 1942. He increased his victory total to 135, including 102 against the Western Allies, but on 23 March 1943, while on his 500th combat mission, he collided with a Spitfire and crashed to his death.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Multiple Independently Targetable Reentry Vehicle (MIRV)

By allowing a single missile to carry more than one warhead and sending each warhead to a different target, MIRVs make a single delivery vehicle far more flexible and dangerous. MIRV technology emerged in the 1970s. President Richard Nixon left it out of the initial Strategic Arms Limitations Talks, believing the Soviets to be far behind in MIRVs and hoping to secure the for United States a decisive advantage even while limiting the number of delivery vehicles. Nixon's estimates were incorrect, and both sides in the Cold War quickly developed and deployed MIRVs on both land-based ICBMs and submarine-based ballistic missiles.

MIRVs made nuclear deterrence less expensive by reducing the number of delivery systems needed to saturate the opponent with nuclear warheads, but many experts felt MIRVs were inherently destabilizing. Not only did MIRVs speed the arms race between the United States and the Soviet Union; they also introduced the use-'em-or-lose-'em factor. A leader facing unclear or unconfirmed evidence of a nuclear attack on his own nuclear assets might be inclined to launch immediately rather than wait for confirmation and risk a massive loss of weapons that might cripple the nation's nuclear war plan. The later Strategic Arms Reduction Talks focused on reducing or eliminating MIRVs.

Grant Weller

See also

Missiles, Intercontinental Ballistic; Strategic Arms Limitations Treaty; Strategic Arms Reduction Talks; Strategic Defense Initiative; Strategic Triad Concept

Mussolini, Benito (1883–1945)

Infamous as Italy's Il Duce, the fascist leader who restored international prestige to Italy but plunged the nation into World War II even though it was financially and militarily unprepared. Assuming power in 1922, he gradually consolidated dictatorial authority by obtaining control over military policy and becoming minister of all three armed services from 1925 to 1929 and again from 1933 to 1943.

Mussolini boasted that he would make Italian lakes of the Mediterranean and Adriatic. He consistently made rhetorical flourishes about Italy's destiny at sea—the rebuilding of the Roman Empire by foreign expansion. To effect this ideology required more than just bluster.

Possessing a tremendous sympathy for the air force, Mussolini thwarted the purchase of navy aircraft carriers by outwardly supporting the air force thesis that Italy was itself an unsinkable aircraft carrier. Sustaining this theory caused the navy in 1940 to have no effective air cover, because interservice rivalry dampened communication between the fleet and the air force's land-based bombers. Although some argued that Mussolini's military policy was based on bluff, between 1935 and 1939 the air force ordered about 8,700 warplanes and almost 3,000 trainers, a sizable fleet by international standards. Its aircraft compared favorably to those of the French in 1939–1940 but not to those of British or German design. Its mainstay fighter, the Fiat CR.42 biplane, despite its maneuverability, had less armament than its British counterpart, the Gloster Gladiator, and was no match for the British Hurricane and Spitfire.

The Italian bomber force was better off. Its mainstay, the Savoia-Marchetti S.79, was by most accounts an excellent aircraft but was difficult to control in inclement weather. The Italian air force's dominant ideology was misconstrued. It professed the theories of strategic air warfare as advocated by General Giulio Douhet, hoping that it would ward off the jealous efforts of the army and navy from throttling the young air arm if not outright reabsorbing it. The air force continued to demand the right to conduct its own war independent of the other services while building forces of medium and light bombers equipped with small and ineffective bombs.

Although desiring to remain neutral, the blustering Mussolini could not tolerate nonbelligerence and maintain Italy's status as a Great Power. He and his military experts knew that Italy's military was not prepared for war and that the Italian people could not sustain a long war. Thus, Mussolini opted for a policy of joining Germany, declaring war on France on 10 June 1940.

Defeats in Greece, Albania, and North Africa accompanied by Allied strikes on Italian industrial cities led to Mussolini's demise. King Victor Emmanuel III, along with army leaders and some fascist party members, had Mussolini arrested and imprisoned. After a daring rescue, the Germans, established him as their puppet head of the Italian Social Republic. Italian partisans executed Mussolini on 28 April 1945 while he was attempting to escape to Switzerland.

George M. Watson Jr.

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Mutual Assured Destruction

A theory of nuclear deterrence—in sum, that nuclear war can be prevented by assuring that both sides would be destroyed in a nuclear exchange. To accomplish this, each nuclear power would need second-strike capability sufficient to destroy the enemy despite a surprise first strike. In such a situation, no one would have an incentive to initiate the use of nuclear weapons, and thus nuclear war would be averted.

The importance of deterrence was recognized at least as early as 1946 by the nuclear theorist Bernard Brodie. In the 1950s, U.S. officials stressed the ability of the United States to destroy the Soviet Union in retaliation for a Soviet initiation of war, a point generally understood as massive retaliation. In private, U.S. military officials further hoped that in the event of a war, the United States could preempt the Soviet Union by striking so hard in the war's first moments that few, if any, Soviet nuclear weapons would survive to reach the United States.

Thus, when Secretary of Defense Robert S. McNamara publicly stated in the mid-1960s that U.S. nuclear strategy was based on the principle of assured destruction, he was simply reemphasizing a long-standing aspect of U.S. nuclear policy. The key question was how much destruction would be sufficient. Eventually it was determined that 20–33 percent of the Soviet population and 50–75 percent of Soviet industrial capacity would have to be wiped out. Though in theory assured destruction was designed to deter the Soviet Union, in practice it was also used within the Department of Defense to curtail ever-growing demands in the U.S. military for more strategic nuclear forces. In this latter capacity it did enjoy some apparent success, as the numbers of U.S. ICBMs and SLBMs remained relatively constant from the mid-1960s through the end of the Cold War (at approximately 1,000 and 650, respectively). This numerical stability may also have represented a recognition of diminishing returns on nuclear targeting.

What disturbed critics of the new policy was not the assured destruction of the Soviet Union but the implicit abandonment of the prospect of preempting the Soviet Union. These advocates of damage limitation argued that it was morally and strategically wrong to allow, let alone embrace, the ability of the Soviet Union to destroy the United States in the case of nuclear war, and they derided the policy as mutual assured destruction (MAD). It nonetheless remained the basic philosophy underpinning U.S. nuclear strategy until the 1980s, when President Ronald Reagan's Strategic Defense Initiative challenged MAD by attempting to reduce the damage to the United States in the case of nuclear war.

This represented only the public side of U.S. nuclear strategy. The extent to which public debates affected actual plans remains a question shrouded in secrecy and continues to surround nuclear targeting policy to the present. In the post–Cold War world, public debate over U.S. nuclear strategy has largely subsided, replaced to some extent by a general emphasis on preventing the proliferation of nuclear weapons to so-called rogue states such as Iran, Iraq, and North Korea.

David Rezelman

See also

Antimissile Defense; Atomic Bomb; Cold War; Massive Retaliation; Missiles, Intercontinental Ballistic; Strategic Air Command

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N

Nagasaki

Site of the second U.S. atomic attack against Japan. When no Japanese surrender was forthcoming after the atomic attack on Hiroshima on 6 August, the United States dropped a second atomic bomb, this time on the city of Nagasaki. On 9 August 1945, the B-29 *Bock's Car* under the command of Major Charles Sweeney took off from the island of Tinian to deliver the plutonium bomb (using Pu-239) code-named "Fat Man" to the primary target, Kokura. But the city was hidden by cloud cover, so the target was changed to Nagasaki, a port city on the southern island of Kyushu that had been placed on the target list very late by military planners. It was an industrial center that housed the Mitsubishi shipyards, a leading producer of aerial torpedoes.

At 11:02 A.M. the city was struck by a weapon that produced the equivalent of 20,000 tons of TNT. The bomb detonated at an altitude of 503 meters and killed approximately 70,000 people (out of 260,000 inhabitants). It wounded at least as many. There was less destruction than in Hiroshima because hills dividing the city in half deflected the blast. Nevertheless, a radius of 6.7 square kilometers and approximately 18,400 buildings were destroyed.

On the day of the Nagasaki bombing, the Soviet Union opened, as Joseph Stalin had promised at the Yalta Conference, a second front and attacked Manchuria. After bitter debates within the Japanese war council, the emperor finally moved toward surrender. On 14 August, Japan surrendered officially. In a radio address, the emperor made mention of the atomic attacks on Nagasaki and Hiroshima. He informed his subjects of the terrible power of the new weapon and warned that it might, should the war continue, lead not only to the destruction of Japan but of civilization itself.

The collective Japanese memory of the atomic bombing was heavily shaped by cultural expressions of victims once the strict censorship of the postwar occupation government was lifted. Most famous in the early years after the war was the best-selling novel *Nagasaki no kane* (The Bells of Nagasaki) by the Catholic doctor Nagai Takashi, who survived the atomic attack with his two children but lost his wife. He continued to live in the ruins and became a charismatic focal point of nuclear martyrdom. He died in 1951 of leukemia. His book and the resulting movie have strongly shaped memorial culture of the atomic bombing of Nagasaki.

Frank Schumacher

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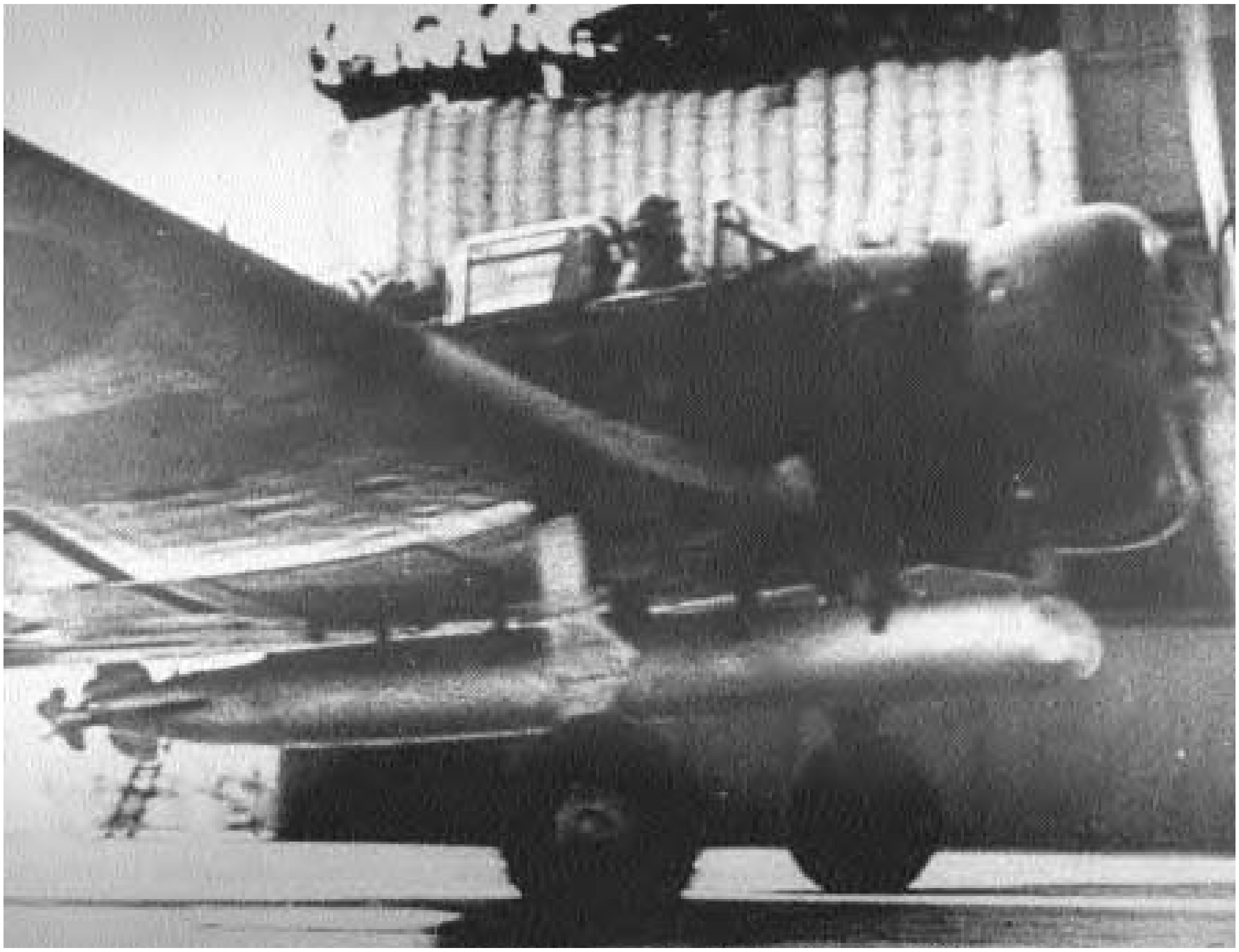
Nagumo, Chuichi (1886–1944)

Japanese admiral. Chuichi Nagumo was born in 1886 and graduated from the Japanese Naval Academy in 1908. He was a torpedo specialist and one of Japan's most experienced sailors at the outset of World War II. In 1941, Nagumo was placed in command of the Kido Butai, Japan's powerful carrier strike force that Fleet Admiral Isoroku Yamamoto planned to use to destroy the U.S. Pacific Fleet at Pearl Harbor. It was an ironic appointment, for Nagumo was an expert in surface, not aerial, operations, he and Yamamoto were not on good terms; and Nagumo opposed the Pearl Harbor operation.

Nagumo's failure to follow up his initial successes at Pearl Harbor and the fact that U.S. aircraft carriers were not pres-



The Nakajima B5N-2 "Kate" was an excellent torpedo plane for its time, and Japanese torpedoes were perhaps the best in the world. With special training, they worked well at Pearl Harbor. (U.S. Navy)

ent meant that the success was far short of what Japan needed or Yamamoto expected.

In spite of Yamamoto's disappointment in him, Nagumo's popularity left him in command of the Kido Butai. Over the next six months it roamed the Pacific, seemingly invincible. In April 1942, four of Nagumo's carriers made a successful air raid on British installations in Ceylon. Although the May engagement at Coral Sea halted the Japanese advance across the Pacific, plans went forward to attack the strategically vital U.S. base at Midway Island in June.

Nagumo survived the disaster of Midway and continued to command the remaining Japanese carrier forces during the August Battle of the Eastern Solomons and the 25–27 October Battle of Santa Cruz (part of the Guadalcanal campaign). Both were Japanese defeats, and by November Nagumo was relieved of his command.

Nagumo was eventually placed in charge of all naval forces in the Mariana Islands region. He was overall commander during the U.S. invasion of Saipan. When it became clear Saipan would fall, Nagumo, feeling responsible for the defeat, took his own life on 6 July 1944.

William Head

See also
Coral Sea, Battle of the; Guadalcanal; Midway, Battle of; Pearl Harbor

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Nakajima Aircraft

Japanese aircraft manufacturer. Nakajima was started in 1917 by retired naval engineer Chikuhei Nakajima and

Seibei Kawanishi as the Japan Aeroplane Manufacturing Work Co. Ltd. In 1920, after a disagreement between the two principals, it became Nakajima Aeroplane Co. Ltd.

In 1924, after several successful airframe designs, Nakajima began producing engines. The first engine produced was a French-licensed water-cooled Lorraine. The following year, Nakajima imported the British Bristol Jupiter. From this engine, Nakajima developed the Model VI.

During World War II, Nakajima was one of the few companies that controlled all aspects of its manufacturing. From airframes to engines to all subparts and assemblies, Nakajima produced each part in its own factory. This allowed Nakajima to produce more than 19,500 aircraft from 1941 to 1945. This made up 28 percent of all Japanese aircraft produced and 37 percent of all Japanese combat aircraft produced. Nakajima provided the Ki 43 Oscar, Ki 44 Tojo, Ki 84 Frank fighters and the Ki 49 Helen heavy bomber for the army. For the navy, it produced the B5N Kate and B6N Jill attack bombers and the J1N Irving twin-engine fighter.

In 1946, Nakajima was reorganized as Fuji Sangyo Co., Ltd. In 1950, Fuji Sangyo was divided into 12 smaller corporations. Between 1953 and 1955, four of those corporations again merged to become Fuji Heavy Industries, the name by which it is still known today.

David A. Pluth

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National Advisory Committee for Aeronautics (NACA)

U.S. government agency for aeronautics and aeronautical research. The United States taught the world to fly, but Europe first exploited the "aeroplane." Secretary of the Smithsonian Institute, Dr. Charles D. Walcott, understood that the lack of coordinated aeronautical research in America had done much to impede aeronautical engineering and public support. In contrast, European governments and industries had worked together to shape a research agenda and had benefited in the form of advanced aircraft engineering and supporting infrastructure.

World War I underscored the differences in the state of aviation that existed between the United States and Europe. In 1914, Walcott began lobbying for the creation of a government agency whose purpose would be one of advancing the science of aeronautics and coordinating aeronautical research. President Woodrow Wilson, concerned that direct government involvement might be viewed as a violation of U.S. neutrality in World War I, opposed the idea. However, when the Navy appropriations bill containing a rider establishing the National Advisory Committee for Aeronautics appeared on his desk, he signed it. NACA was officially established on 3 March 1915.

The new law required the composition of NACA to be both military and civilian. President Wilson appointed NACA's first 12 members, including four representatives of the Army and Navy; seven scientists, such as Joseph S. Ames from Johns Hopkins University; and a nontechnical representative. Walcott, who became its first chair, represented the Smithsonian Institution.

The purpose of NACA, according to the enabling legislation, was to "direct" and "supervise" scientific aeronautical research. During the next 43 years, NACA was responsible for the advancement of aeronautical research, including the development of airfoil standards, engineering standards, research instrumentation, and enhanced wind-tunnel testing techniques.

The NACA also played an important role in the development of commercial aviation, greatly influencing legislation that ultimately defined commercial aviation, the Air Commerce Act of 1926. On 23 March 1921, Walcott wrote to Herbert Hoover, the secretary of commerce under President Warren Harding, outlining NACA's position for the advancement of commercial aviation. Under the NACA proposal, the Departments of War and Navy would retain control of their individual air arms, NACA would continue its mission as focal point for "aeronautical activities" and "direct continuous prosecution of scientific research in aeronautics," and a Bureau of Aeronautics would be created within the Department of Commerce. NACA considered commercial aviation to be the "backbone of military preparedness."

NACA continued its mission until 1958, when President Dwight Eisenhower signed into law the National Aeronautics and Space Act, transforming NACA into the National Aeronautics and Space Administration.

Randy Johnson

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National Aeronautics and Space Administration (NASA)

U.S. government agency that coordinates aeronautics, aerospace exploration, and related research. Deriving from the National Advisory Committee for Aeronautics (1915–1958), NASA was officially established on 1 October 1958. Designed to explore scientific and technological experiments in human spaceflight, NASA's ongoing efforts contribute greatly to aerospace exploration, space science, and space applications. Experimentation by NASA has expanded our knowledge of the universe and the earth and has resulted in advances in airpower, computing, medicine, meteorology, communications, and applied science. Preparing astronauts for existence in space has advanced many fields of human activity.

In the mid–twentieth century, Project Mercury explored human survival in space. Project Gemini followed, with a spacecraft built for two astronauts, and Project Apollo set its sights on exploration of the moon. In 1969, astronaut Neil Armstrong was the first to walk on the lunar surface. Following Skylab and the Apollo-Soyuz Test Projects in the 1970s, NASA's human spaceflights resumed in 1981 with the Space Shuttle program. The International Space Station (under construction) links NASA and the United States with other nations in far-reaching and innovative global cooperation.

NASA's continuing interest in flight brought about joint ventures with the Department of Defense and United Kingdom in pioneering vertical-takeoff-and-landing aircraft and fostering the research and technology for an advanced short-takeoff-and-landing aircraft. NASA undertook flight research with the forward-swept-wing X-29 and with the development of low-speed propfan technology for fuel efficiency in subsonic airliners of the future.

Headquartered in Washington, D.C., NASA operates through the following field centers, each with areas of emphasis and expertise:

* Ames Research Center, Information Technology, Sunnyvale, CA
* Dryden Flight Research Center, Atmospheric Flight Ops, Edwards, CA
* Glenn Research Center, Turbomachinery, Cleveland, OH
* Goddard Space Flight Center, Scientific Research, Greenbelt, MD
* Independent Validation and Verification Facility, Software Systems, Fairmont, WV
* Jet Propulsion Laboratory, Deep Space Systems, Pasadena, CA
* Johnson Space Center, Human Operations in Space, Houston, TX
* Kennedy Space Center, Launch and Cargo Processing Systems, Titusville, FL
* Langley Research Center, Structures and Materials, Hampton, VA
* Marshall Space Flight Center, Space Propulsion, Huntsville, AL
* Moffett Federal Airfield, Shared Federal Facility, Sunnyvale, CA
* Stennis Space Center, Propulsion Testing Systems, Slidell, MS
* Wallops Flight Facility, Suborbital Research Programs, Wallops Island, VA
* White Sands Test Facility, Testing and Evaluating Hazardous Materials, Components, and Rocket Propulsion Systems, Las Cruces, NM.

NASA continues to blaze the path into space with the International Space Station, research vehicles that travel to the outer reaches of the solar system, as well as unmanned Mars landings and plans for a manned flight to Mars.

Ann Cooper and Charles Cooper

See also

National Advisory Committee for Aeronautics

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National Emergency Airborne Command Post (NEACP)

Beginning in 1965, specially modified Boeing EC-135Js based at Andrews Air Force Base, operated under Project Nightwatch as the National Emergency Airborne Command Post. These aircraft were flown by the 1st Airborne Command and Control Squadron (1st ACCS), reporting directly to Air Force Headquarters.

The E-4A (a version of the Boeing 747–200) was assigned to the 1st ACCS on 1 November 1975. An improved version, the E-4B, was introduced on 4 August 1976. On 1 November 1975, the 1st ACCS was reassigned to the 55th Strategic Reconnaissance Wing (55th SRW) and became part of Strategic Air Command. In addition to the flight crew, the E-4s carried a battle staff and a ground-security element from the 55th SRW Security Police Squadron.

The mission of NEACP airplanes is to provide an airborne haven for the president of the United States and his immediate staff in the event of a nuclear attack. From this aircraft, the president and his advisers—supported by the airborne battle staff—would be able to maintain command and control of U.S. forces.

Alwyn T. Lloyd

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National Security Act of 1947

Legislation passed by the United States Congress that made sweeping changes to America's defense organization. After World War II, the Air Force Association of wartime veterans lobbied Congress for a separate air branch of the military. The United States Air Force was established on 17 September 1947 as a separate entity, coequal with the Army and Navy. General Carl A. "Tooey" Spaatz was named the first Air Force Chief of Staff.

The Departments of War, Army, and Navy were combined into the Department of Defense. James V. Forrestal, former secretary of the Navy, became the first secretary of defense. While the Joint Chiefs of Staff coordinated military activities, the National Security Council worked as the interface between the Department of Defense and the State Department and served as an adviser to the president. An outgrowth of the World War II Office of Special Services, the Central Intelligence Agency (a branch of the National Security Council) was tasked with correlating and evaluating all intelligence activities involving national security except internal security, which came under the purview of the Federal Bureau of Investigation. Rear Admiral Roscoe Hellenkoeter was made the first director of the CIA.

Alwyn T. Lloyd

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National Security Council (NSC)

Established by the National Security Act in 1947 to advise the U.S. president on domestic, foreign, and military policy related to national security. A later amendment placed the NSC within the Executive Office of the President (EOP). The NSC is the highest executive-branch entity reviewing and providing guidance for the conduct of national security policy.

The statutory members of the NSC are the president, vice president, secretary of defense, secretary of state, director of the Central Intelligence Agency, Chairman of the Joint Chiefs of Staff, and the national security advisor (NSA), who has primary responsibility for the daily management of the NSC and is the principle adviser to the president with respect to national security affairs.

Because the NSC is part of the EOP, it has traditionally been regarded as beyond congressional oversight. For this reason presidents have occasionally employed NSC staff in tasks and missions to avoid the risk of public disclosure that relying on other agencies of the government might entail. (Iran-Contra, the arms-for-hostages scandal during Ronald Reagan's presidency, is one example.)

Craig T. Cobane

See also

Central Intelligence Agency

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Naval Aircraft Factory (NAF)

U.S. government-owned and -operated aircraft manufacturing facility (1917–1956) created in part as a progressive response to wartime profiteering at the start of U.S. involvement in World War I. The NAF was established to meet the Navy's needs for long-range flying boats. Construction began on 10 August 1917 at the Philadelphia Navy Yard, and the NAF's first assembly building was ready for occupancy on 28 November 1917; the first airplane, a Curtiss-designed H-16 twin-engine flying boat, flew on 27 March 1918.

To produce the large numbers of H-16 and F-5-L flying boats needed by the Navy, NAF turned to subcontractors for components, heralding a fundamental structural change in the U.S. aircraft industry that enabled it to expand output during both world wars. At the height of the conflict, NAF employed 3,640 workers, nearly a quarter of them women. After World War I, successive aircraft in the PN series of flying boats pioneered metal airframe construction in the navy.

The factory was also responsible for the fabrication of ZR-1 *Shenandoah,* the Navy's first rigid airship, in 1919–1923, the GB-1 Giant Boat, TS-1 shipboard fighters, record-breaking Navy racing aircraft, catapults and arresting gear, and pilotless aircraft and guided missiles. In addition, the NAF was at times the Navy's chief aviation overhaul and repair facility, and its supply department was the major disbursing agency for aircraft parts and equipment. As the nation's only government-owned and -operated aircraft manufacturing facility, the NAF became the center of a dispute with private industry over aircraft and engine procurement.

To guarantee an autonomous source of airplanes, naval officers argued for retention of the aircraft design and manufacturing capabilities of the NAF after World War I. This attitude coincided with that of political leaders and the general public, who castigated armsmakers for unconscionable profits in the sale of weapons and who considered the NAF and other government facilities vital to maintaining a competitive environment and as yardsticks in the accurate determination of the costs of privately supplied material. Moreover, as an integral unit within the Bureau of Aeronautics, the NAF provided a valuable opportunity for naval officers to learn firsthand how an airplane was designed and built, how to draw up specifications, and how to negotiate contracts. The NAF also provided technical verification of airplanes, engines, and components. Starved for orders after World War I, the civilian aviation industry regarded the NAF as anathema and demanded the elimination of the factory's design and production activities.

Rear Admiral William A. Moffett, chief of the Bureau of Aeronautics, arranged a compromise in 1922 whereby the NAF ceased series production in favor of designing and building limited numbers of airplanes and doing specialized work that did not appeal to most aircraft manufacturers. In 1934, as a result of the Vinson-Trammell Act, production returned to Philadelphia with the design and construction of the famous N3N series of biplane trainers, nearly 1,000 of which were completed by 1942. During World War II, the NAF produced variations of private designs, among them 300 OS2N-1 scout-observation airplanes (similar to the Vought OS2U Kingfisher) and 156 PBN-1 twin-engine flying boats (an improved version of the Consolidated PBY Catalina). By 1944, employment at the factory reached 13,400.

After World War II, the factory ended aircraft production and focused its activities on experimental projects and research and development. Laboratories specialized in testing material, structures, power plants, and instruments for the Navy. The Naval Air Material Center, created in 1942, provided administrative oversight for the factory, its labs, the Aviation Supply Office, the Aeronautical Engine Laboratory, and other engineering and experimental offshoots of the original factory. On 9 May 1956, the Navy redesignated the factory as the Naval Air Engineering Facility (Ship Installations), although many of its previous activities continued under successor organizations into the early 1990s.

William F. Trimble

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NAVSTAR Global Positioning System

For thousands of years, the ability to determine one's position and to move precisely from place to place has proved vital to the success of military and other ventures. Travelers devised various methods to plot their location and course: observing familiar landmarks (pilotage); noting the positions of the sun and stars (celestial navigation); assuming or estimating speed, time, and direction of movement (dead-reckoning); using extremely accurate instrumentation to measure acceleration in all directions and computers to integrate that data for calculation of velocity and position (inertial navigation); and employing electronic signals from ground- or space-based transmitters (radio navigation). Satellites were first used for radio navigation in a system called TRANSIT, which the Applied Physics Laboratory of Johns Hopkins University and the U.S. Navy developed during the early 1960s for the Navy's submarine ballistic missile system. Since it took several minutes to receive the TRANSIT signals needed to calculate one's position exactly, the system was practical only for slow-moving platforms. Given the further limitation that TRANSIT worked in only two dimensions, it could not fulfill the navigational requirements of high-speed aircraft, rail-mobile ICBM launch crews, and operators of other rapidly moving platforms.

To meet those requirements, the services sought to demonstrate the feasibility of a defense navigation satellite system. The Navy weighed in with TIMATION, a program for two-dimensional navigation and time transfer based on atomic clocks. In October 1963, the U.S. Air Force directed the Aerospace Corporation to pursue design of a highly accurate, three-dimensional capability officially designated System 621B (Satellite System for Precise Navigation). Phil Diamond, director of System 621B study at the Aerospace Corporation, unofficially dubbed the proposed capability the Global Positioning System (GPS), and in May 1974 the system officially became the Navigation Satellite Time and

Ranging (NAVSTAR) GPS. Much of the conceptual work essential to its success had been initiated during the late 1950s by Ivan Getting, then Raytheon Corporation's vice president for engineering and research and, subsequently, first president of the Aerospace Corporation. Nevertheless, several scientists at the U.S. Naval Research Laboratory also made important technical contributions, especially in design of highly accurate onboard cesium and rubidium clocks. A 17 April 1973 memorandum issued by Deputy Secretary of Defense William Clements designated the Air Force as the "executive service" to merge the various satellite navigation efforts into a single comprehensive system. The Air Force established a GPS joint program office in July 1973 and proceeded with the first phase of development—concept validation—in December 1973.

Engineers envisioned a system consisting of a 24-satellite constellation, utilizing six orbital planes at a 55-degree inclination, with a minimum of four satellites per plane. Orbiting at an altitude of 10,900 miles, the GPS satellites would transmit signals on two different L-band frequencies. Anyone, military or civilian, possessing a hand-held receiver about the size of a cellular telephone could process the signals and determine their position in three dimensions to an accuracy of about 50 feet, as well as the time at that location to within one-millionth of a second. Using an S-band signal, the Air Force could monitor all the satellites from five different stations—Kwajalein, Hawaii, Diego Garcia, Ascension Island, and Colorado—and command them from a master control station at Schriever Air Force Base near Colorado Springs.

Planners envisioned a multitude of military and civilian uses for GPS. It would guide infantry, armor, air, and sea forces to their desired destinations in a highly coordinated fashion. Furthermore, the system would enhance delivery of weapons, air-traffic control, rendezvous for air refueling, all-weather airdrops, photomapping, missile guidance system updating, minelaying and -sweeping, antisubmarine warfare, range instrumentation, search and rescue, and satellite navigation. Civil uses included managing global airspace, locating commercial fishing traps and gear, monitoring icebergs, navigation for motor vehicle operators, train control and collision avoidance, precision timing for computer networks, surveying and prospecting for natural resources, hiking and other recreational activities, ground mapping of ecosystems, law enforcement activities, and farming. Despite this broad range of dual uses, military and civil, nobody foresaw the phenomenal growth in worldwide demand for GPS services, which a 1995 report projected would exceed $31 billion annually by 2005.

With the end of concept validation in August 1979, full-scale development and system testing began using Block I satellites. That phase of the program continued into 1985, when production and deployment of the operational system commenced. In February 1989, the Air Force launched the first Block II GPS satellite from Cape Canaveral Air Station, Florida, atop a Delta II rocket. Although the full 24-satellite constellation would not be completed until 9 March 1994, GPS contributed mightily to the performance of Coalition land, sea, and air forces in the Persian Gulf region during Operation DESERT STORM in 1991. Troops carried more than 9,000 portable receivers, many of them commercial models due to a shortage of more accurate military models, and GPS was used strategically to ensure that sea- and air-launched cruise missiles reached their targets. Shortly after the conflict, Lieutenant General Thomas S. Moorman Jr., commander of Air Force Space Command, described GPS as "critical to the victory." Two years later, during Operation RESTORE HOPE, GPS proved essential to ensuring the successful air-dropping of food and supplies into remote areas of Somalia. Meanwhile, in 1992 the National Aeronautic Association awarded its prestigious Collier Trophy to the GPS team—the Aerospace Corporation, U.S. Air Force, U.S. Naval Research Laboratory, Rockwell International Corporation, and IBM Government Systems.

Rick W. Sturdevant

See also
Satellites

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Nesterov, Pyotr (1887–1914)

Pioneer aviator and Russian war hero. Pyotr Nikolaevich Nesterov was born February 27, 1887, in Nizhnyy Novgorod in a military family. As was customary for his social class at that time, he was educated in a cadet school, then attended a military academy. Commissioned into the artillery in 1906, his first assignment was as an observer in the balloon detachment at Vladivostok. He became obsessed with flying and began to study. In 1909, he designed his first airplane, an advanced concept utilizing a V-shaped tail, which was not accepted for building, and in 1911 he first flew in a glider of his own design.

In 1912, Nesterov was transferred to the aviation branch and trained as a pilot. He was often in trouble for his continuing experiments, including a steep banked turn then considered reckless. On 8 September 1913, Nesterov executed the world's first full vertical loop, for which he suffered 10 days' arrest. On 11 February 1914, he became commander of XI Corps Aviation Detachment, which later proved to be Russia's preeminent flying unit during World War I. On 25 August 1914, Nesterov completed possibly Russia's first bombing mission, when his observer dropped grenades on Austrian troops. Two days later, on 27 August, Nesterov went aloft to intercept an Austrian Albatros reconnaissance airplane that had been troubling the Russians. Determined to destroy the enemy at any cost, but having no gun, Nesterov dived on the Albatros and rammed its upper wing with his landing gear and propeller. Both machines crashed to earth, and Nesterov was killed. Because of the circumstances of his death, as well as his potential as an exemplar, Nesterov was one of the few czarist officers honored by the Soviets even during their early years, and he has remained one of the patron saints of Russian aviation.

George M. Mellinger

See also
Imperial Russian Air Service; Taran

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Netherlands East Indies (1942)

Site of early Japanese successes during World War II. In early 1942, the Japanese moved toward the Dutch East Indies in force. Dutch airpower on Java consisted of only a few obsolete Fokker fighters and U.S.-built Martin B-10 bombers. These were reinforced by several British Hawker Hurricanes flown in from HMS *Indomitable* and some U.S. Curtiss P-40s, as well as various survivors of the debacle in Malaya, such as RAF Lockheed Hudsons and Bristol Blenheims and Fleet Air Arm Vickers Vildebeest torpedo-bombers.

This polyglot Allied force (ABDA, for American, British, Dutch, Australian) was heavily outnumbered in the air by the Japanese 23d Naval Air Flotilla. The Japanese seized one lightly defended island after another: Tarakan off Borneo on 11 January, Celebes on 24 January, Amboina (Ambon) on 31 January, Bali on 19 February. Sumatra, with its important oil fields, was invaded on 14 February. In one of the few parachute drops of the Pacific War, Japanese airborne troops seized airfields on Sumatra.

Four Japanese carriers passed through the East Indies on their way to the Indian Ocean. Aircraft from this fleet attacked Port Darwin in Australia on 15 February, causing heavy damage.

The old U.S. carrier *Langley,* converted to an aircraft transport, sailed from Australia with a load 32 P-40E fighters and a freighter with 27 more crated P-40s. Japanese aircraft found these ships just south of Java, however, and sank *Langley.* The crated P-40s could not be unloaded after they reached Java and had to be thrown into the sea.

As a result, the Japanese invasion fleet approached Java virtually unhindered by Allied air threat. ABDA's surface naval force under Dutch Admiral Karel Doormann attempted to interfere but was defeated in the Battle of Java Sea. Japanese forces landed on Java on 1 March, and resistance ended on 9 March with almost 100,000 Allied troops taken captive. Throughout the campaign, the Japanese proved adept at quickly and effectively preparing newly seized advanced bases for air operations.

Frank E. Watson

See also
Curtiss P-40 Warhawk; Hawker Hurricane

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Neuve Chapelle, Battle of (1915)

The world's first real lesson in modern trench warfare. Throughout World War I, the fighting subsided during winter while the armies geared up for the following spring. Following the initial war of movement in 1914, soldiers had settled into the trenches. Their first significant emergence during 1915 was at the Battle of Neuve Chapelle, which began on 10 March.

During the winter lull, experiments in aerial photography had been conducted, and just before fighting renewed, a series of vertical shots was taken by the Royal Flying Corps (RFC). For the first time, such photos were assembled like a jigsaw puzzle, and from the resulting panorama a set of maps of the German trenches was made. Consequently, when British troops went over the top at the opening of the battle, they went equipped with an accurate description of German positions. The photos and maps had also been used by the artillery in making plans for the destruction of enemy assets.

The effective use of photography was not the only first at Neuve Chapelle. Aircraft had been used for bombing since the opening days of the war, but in planning for Neuve Chapelle the British command for the first time assigned specific targets to the RFC, expecting aircraft to be responsible for objectives beyond the reach of the artillery.

Since no World War I battle can be accurately assessed without considering the artillery, it needs be said that following the initial artillery bombardment aircraft were expected to form an integral link in the regulation of counter-battery fire. This would be achieved for the first time by wireless, each RFC squadron having been equipped with transmitters (they could still not receive) in order to send corrections to the batteries.

The battle was not a complete aerial success. Although command was beginning to appreciate the potential of the third dimension, its use was not yet fully understood. The military eye had not yet been completely trained, and though it knew something important was being seen, the accurate interpretation of aerial photos still lay in the future. Enemy strength was underestimated, and the hoped-for results were not achieved. The proper exploitation of aerial reconnaissance during a battle—for example, the use of contact patrols to locate the front line—also lay ahead. But a foundation had been laid, and a glimpse of the potential of airpower had been seen.

James Streckfuss

See also

Royal Flying Corps/Royal Naval Air Service/Royal Air Force; World War I Aviation

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Nguyen Cao Ky (1930–)

South Vietnamese aviator and political leader. Nguyen Cao Ky was born on 8 September 1930 in Son Tay Province, northwest of Hanoi, the only son of a schoolteacher father. In 1951, he was drafted into the Vietnamese National Army, later being commissioned an infantry lieutenant. He volunteered for pilot training, spending three years in Morocco, France, and Algeria learning to fly combat and transport aircraft.

He returned home as a rated pilot in 1954 as the French withdrew from Indochina. He joined the Republic of Vietnam Air Force (RVNAF) in South Vietnam. By 1960, Major Ky commanded Tan Son Nhut Air Base near Saigon. He also flew agents into North Vietnam for William Colby, Saigon station chief for the Central Intelligence Agency.

In November 1963, Ky played a role in the coup against Ngo Dinh Diem by securing RVNAF support. Coup leader General Duong Van "Big" Minh promoted Ky to brigadier general and RVNAF commander. Soon members of the new Military Revolutionary Council (MRC) began to plot against each other. In January 1964, Ky supported Major General Nguyen Khanh's coup against Minh. Khanh became premier and appointed Ky air vice marshal.

On 21 July 1964, Ky garnered international attention when he publicly disclosed his work for the CIA and advocated the systematic bombing of the North. In December, part of a military faction known as the Young Turks, which included Major General Nguyen Van Thieu, replaced the older officers in the MRC, creating the Armed Forces Council (AFC) in January 1965.

By February 1965, Ky, alarmed by rumors that Khanh was secretly seeking negotiations with the National Liberation Front and supported by U.S. Generals Maxwell Taylor and William Westmoreland, sought to remove Khanh. On 24 February, Khanh left South Vietnam for the last time, as a "roving ambassador."

Earlier, on 8 February, the swashbuckling Ky again captured worldwide attention by leading RVNAF air strikes during Operation FLAMING DART I, President Lyndon Johnson's reprisal attacks against the Dong Hoi military barracks north of the Demilitarized Zone.

On 12 June, Ky, Thieu, and General Nguyen Huu Co replaced the AFC with the 10-member National Leadership Committee (NLC). Ky became chief executive (premier), running the daily business of government, and Thieu became chief of state. Ky tried to institute what he called "social justice." He strengthened the military, instituted needed land reforms, initiated school and hospital construction, and facilitated economic reforms such as price controls. He also tried to purge corruption from his government.

Unfortunately, there was a dark side to Ky. He took repressive measures against the media and violated individual civil liberties. Between April and June 1966, supported by the United States, he used troops and heavy weapons to suppress Buddhist dissidents, accusing them of communist sympathies.

In February 1966, Ky met with President Johnson for two days in Hawaii. The meeting enhanced his credibility, and it led to democratic reforms in the South. Between May 1966 and May 1967, a new constitution was created calling for a powerful president, premier, and cabinet responsible to a two-chamber legislature.

As the September presidential elections approached, tensions between Ky and Thieu rose. Many South Vietnamese leaders feared hostilities. Instead, the NLC forced Ky and Thieu onto a joint ticket, with the older Thieu as the presidential candidate and Ky as the vice presidential candidate.

Thieu and Ky defeated 10 other tickets, receiving 34.8 percent of the vote. Although some have questioned the process, it seems that it was a fair-enough election to suggest that Thieu and Ky should have won. Over the next four years, Ky's influence faded. In 1971, Thieu passed a law to block Ky and others from running for president. Although the Vietnamese Supreme Court overturned the law, Ky did not run. Thieu won, but his high-handed style damaged the new government's status.

Ky left the government but remained publicly active. In 1975, South Vietnam was faced with the communists' Ho Chi Minh Offensive. Ky's later writings and public statements criticize Thieu's tactical withdrawal of Army of the Republic of Vietnam (ARVN) forces from the Central Highlands. He believed this led to the disintegration of ARVN resistance.

In early April, Ky participated in a public demonstration in front of the U.S. Embassy, where he and hundreds of officers vowed to stay and fight. On 29 April, he flew a helicopter to USS *Midway* and left Vietnam. He emigrated to Los Angeles and opened a liquor store. He seemed to do well, but in 1985 he declared bankruptcy, citing a $20,000 gambling debt.

Since then, Ky has maintained a low profile, rarely making public appearances. It has been said that, unlike many U.S. leaders of the time, Ky "remains thoroughly unrepentant." Many would argue that he has little for which to repent.

William Head

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NICKEL GRASS (1973)

Code name for 32-day airlift by U.S. Military Airlift Command (MAC) Lockheed C-141s and C-5s into the intense fighting of the Arab-Israeli Yom Kippur War. Neither as well known as the Berlin Airlift nor as large as DESERT STORM, Operation NICKEL GRASS airlifted thousands of tons of materiel and restored the balance of power, helping Israel survive the Soviet-backed assault from Egypt and Syria. It also solidified the U.S. Air Force's theory of global mobility while transforming the C-5 Galaxy's image from expensive lemon to potent symbol of U.S. airpower.

In 1967, the Israelis captured large areas of Egypt, Syria, and Jordan. Diplomatic efforts to persuade or even force the release of those lands had failed. By 1973, Egypt and Syria were carefully planning an offensive to bring about that goal, and on 6 October they attacked, catching Israel by complete surprise. The Egyptian Third Army pretended to conduct exercises until the Israelis began to ignore their machinations. Choosing the most holy day in the Jewish calendar, Yom Kippur, the Day of Atonement, in hopes of catching the Israelis off-guard, the Egyptians attacked across the Suez Canal. The Israeli army was overconfident and indecisive at the operational and strategic levels. Egyptian forces pressed

For many years a highly controversial aircraft, the Lockheed C-5 Galaxy proved itself beyond doubt in the Yom Kippur War, during Operation NICKEL GRASS. (Walter J. Boyne) their advantage and quickly overwhelmed Israeli forces at the beginning of the war.

Israeli Prime Minister Golda Meir asked U.S. President Richard M. Nixon for help. Paralyzed by events at home—the end of the Vietnam War, Watergate, and the resignation of Vice President Spiro T. Agnew—Nixon was slow to respond. Moreover, coming to Israel's aid would require a balancing act: protecting the new détente that had been achieved with the North Vietnamese at the Paris peace talks while avoiding an Arab oil embargo against the West.

On 9 October, Nixon responded to Meir's request for the U.S. resupply of Israel. It took four more days to decide how that effort would take shape. It was Nixon who, on 12 October, made the decision that MAC aircraft would be used. The Air Force had been preparing for the contingency, and in nine days MAC's 268 C-141 Starlifters and 77 C-5s were ready—but not fast enough for Nixon.

The fear of an oil embargo caused some U.S. allies to deny landing and air access to the flights. Only Portugal agreed, allowing the airlift to use Lajes Field in the Azores. The average distance from the points of departure in the United States to Lajes was 3,297 miles, with another 3,163 miles from Lajes to Lod/Ben-Gurion Airport in Israel. The aircraft flew to Gibraltar in Spain, then along a narrow corridor across the Mediterranean on the Flight Information Region Boundary line that divided the airspace of hostile African states to the south and friendly European states to the north.

The U.S. Sixth Fleet provided protection for the transports until they were within 200 miles of Israel, at which time Israeli Defense Force fighters took over. Relieved Israelis greeted the MAC airplanes and developed a system to accelerate unloading procedures.

With the 4,000-ton airlift requirement growing daily, the USAF sent four C-5s and 12 C-141s. By 21 October, six C-5s and 17 C-141s moved in and out daily, a level maintained until 30 October, when requirements began to decline.

Because of the continuous supply of war materiel from the United States, the Israelis did not need to conserve ammunition and other consumables. As a result, the Israelis could mount an offensive late in the war. In the north, they recovered lost ground and began to march on Damascus. In the Sinai, tank forces crossed the Suez Canal, encircled the Egyptian Third Army, and threatened Ismailia, Suez City, and Cairo. Egypt and Syria had previously refused to negotiate, but to prevent the destruction of the Egyptian Army, on 22 October they accepted a cease-fire brokered by Washington and Moscow.

Israel wanted to gain as much as possible before the cease-fire, so it was reluctant to comply. Moscow threatened unilateral action, and on 24 October the United States took its armed forces to DEFCON III alert to demonstrate its willingness to use whatever force necessary. After several fruitless attempts, the cease-fire began on 28 October.

The airlift officially ended on 14 November. The Air Force had delivered 22,395 tons of cargo during 145 C-5 and 422 C-141 sorties. The C-141s had carried more tonnage, but the C-5s had delivered outsized equipment that only they could carry—M-60 tanks, 155mm howitzers, ground radar systems, mobile tractor units, CH-53 helicopters, and A-4E components.

The airlift proved vital to Israel's victory. Moreover, the performance of the U.S. transports substantiated that they were both reliable and economical, with the C-5 about 81 percent reliable and the C-141 about 93 percent reliable. No accidents occurred, and less than 2 percent of scheduled flights had to be aborted.

In the lessons-learned column, Air Force officials placed the importance of Lajes as a forward staging area and the need for aerial refueling as a standard practice. Indeed, Operation NICKEL GRASS directly resulted in the modification of the C-141 for aerial refueling. Moreover, the realization that commercial airlines could not be expected to meet airlift requirements with volunteer manpower and machinery brought about the consolidation of airlift aircraft under MAC and its designation as a specified command on 1 February 1977. Finally, the C-5 proved its worth and that it was not the costly military mistake portrayed by the media.

Diane Truluck

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Nieuport Aircraft

One of the major aircraft builders during World War I. The firm built both two-seat and single-seat designs, most of which were best known for their sesquiplane layout. The sesquiplane—literally, "one-and-a-half-wing"—had a full-size upper wing and a narrow-chord single-spar lower wing. The intent was to maximize the downward view.

Nieuports were light on the controls and maneuverable. Powered by rotary engines ranging in rating from 80 horsepower to an eventual 150 horsepower, armament was generally provided either by a Lewis machine gun on an elevated mount to allow fire over the propeller or a synchronized Vickers firing through the arc. Occasionally, both types of guns were carried, but the extra weight of the second gun was usually too much for the aircraft. Le Prieur rockets, intended for use against balloons, were sometimes fitted on the struts.

The first of the single-seat "V-strutters"—the little Nieuport 11—may also have been the first aircraft to have worn the kind of bright colors that characterized fighter aircraft in the later years of the war when French ace Jean Navarre painted the fuselage of his aircraft bright red.

The Nieuport Type 11, nicknamed Bébé (Baby), was the first successful French single-seat fighter. The Bébé was powered by the 80-hp LeRhone rotary engine and mounted an elevated Lewis machine gun. The Nieuport 11 earned its fame in the fight against the Fokker Eindecker, which it was generally able to outmaneuver.

A succession of improved and enlarged versions of sesquiplane Nieuports followed. Despite the inherent structural problem of the V-strut, they were used with great success. The most handsome of the line, the Nieuport 28, returned to a conventional biplane layout and was powered by the large 160-hp Gnôme rotary engine. Armament was also upgraded from earlier practice, with twin Vickers machine guns being carried in lieu of the single Vickers or Lewis that had generally supplied the muscle of the earlier types.

Refused by the French for their own air force, the Nieuport 28 was plagued with inflight fires and structural failures, including the separation of the upper wing's leading edge in a dive. Nonetheless, it served well in U.S. units, to which the French handed it off.

The earlier V-strut models did not vanish from the scene completely. They continued to serve as advanced trainers in French schools as well as at the U.S. Third Aviation Instruction Center at Issoudun.

Identification of the individual Nieuport models in historical records is sometimes complicated by references to the square-meter area of the wings rather than official model numbers.

James Streckfuss

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Nieuport-Delage NiD-29

The immediate successor of the SPAD fighters in the French squadrons after World War I. Although slower than the Wibault 1, it was preferred by the French for its better control harmonization and efficiency.

An answer for a 1917 fighter program, the first of three prototypes flew in 1918. Production models of the NiD-29C1 reached operational units in 1922. Five years later, 620 had been delivered to the French air force, and a total of more than 700 were produced for France until 1928. Only three saw active service, used during one month in Morocco for bombing and strafing against rebels.

The NiD-29C1 was a great export success. Spain bought 30, Belgium 109, Italy 181 (including 175 produced under license), Sweden 10 (called J2), and Argentina and Siam unknown quantities. The most important customer was Japan, with no less than 608 built as the Ko 4 between 1924 and 1932. It was the front-line fighter of the Japanese army for several years and fought during the Japanese war against China. Some Ko 4s were still used for training when Japan entered World War II. The NiD-29C1 is one of the very few aircraft whose service life spanned both world wars. In its heyday in 1924, it was considered by U.S. General Billy Mitchell to be the best pursuit plane of the high-speed diving type in the world.

Stéphane Nicolaou

Night Witches (46th Guards Night Bomber Regiment)

The only all-woman aviation unit in history and one of the most distinguished Soviet air units in World War II. During autumn 1941, after intense urging by the famed female aviator Marina Raskova, Soviet dictator Joseph Stalin authorized the creation of three regiments of women aviators. One was the 588 NBAP (Night Bomber Aviation Regiment), established at Engels in December 1941. Although the other women's regiments later acquired some male members, the 588th remained totally female. Committed to battle in May 1942, the regiment flew the Polikarpov Po-2 biplane trainer, equipped as a night-bomber. Their bombing deprived the German troops of sleep and frequently caused serious damage to German supply depots and headquarters. When the Germans discovered that some of the crews were women, they named them the Night Witches. Flying up to 15 sorties a night, many crews flew 700–1,000 missions. In recognition of its outstanding accomplishments, on 8 February 1943 the 588 NBAP was honored as the 46th Guards Regiment. During the war the 46th flew about 24,000 sorties, lost 30 airwomen, and saw 23 of its members awarded the Hero of the Soviet Union.

George M. Mellinger

See also

Polikarpov, Nikolai N.; Raskova, Marina Mikhaylovna

Some of the great architects of naval victory in World War II: from the left, Admiral Raymond A. Spruance, Fleet Admiral Ernest J. King, Fleet Admiral Chester W. Nimitz. With them is Brigadier General Sanderford Jarman. (U.S. Navy)

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Nimitz, Chester William (1885–1966)

U.S. admiral and master of the operational art of war; commanded in the Pacific during World War II. Born in Fredericksburg, Texas, on 24 February 1885, Nimitz attended the U.S. Naval Academy, graduated in 1905, and served on and commanded surface ships and submarines. Other command assignments included submarine, cruiser, and battleship divisions. He served in no major aviation-related positions. Staff assignments culminated in promotion to rear admiral and assignment as chief of the Bureau of Navigation in 1939. Shortly after Pearl Harbor, Nimitz was selected to command the U.S. Pacific Fleet and, soon, all Allied forces in the Pacific.

Nimitz appreciated the offensive capabilities of naval aviation and was blessed with competent and aggressive subordinates on whom he relied. Nimitz risked defeat in carrier battles at Coral Sea (May 1942) and Midway (June 1942) to gain major victories that decimated Japanese carrier-based airpower and turned the war in the Pacific.

These battles also won back the Solomon Islands (February 1943) and set the stage for success in campaigns for the Gilbert Islands (November 1943), the Marshall Islands (February 1944), and the Mariana Islands (August 1944). Commanding from Hawaii, Nimitz oversaw major victories at Leyte Gulf (supporting the Philippines campaign), Guam, Iwo Jima, and Okinawa. Throughout, he used carriers offensively, taking the war to the enemy, while not ignoring air support for the amphibious operations necessary to reach Japan.

Nimitz took strategic guidance from Admiral Ernest King—his superior as Chief of Naval Operations (CNO) and commander in chief of the U.S. Fleet—and often left the tactical details to trusted subordinates like Admiral William "Bull" Halsey. Nimitz concentrated instead on the operational level of the U.S. war effort in the Pacific. A thorough campaign planner, Nimitz ensured solid logistical support for operating forces, utilized invaluable intelligence at critical junctures, and maneuvered his carrier forces boldly when victory required it.

Nimitz coordinated his movements with his neighboring Allied commander, General Douglas MacArthur, on his flank. Nimitz's ability to provide operational naval air support to MacArthur while conducting his own island-hopping campaign was masterful.

Nimitz was promoted to the five-star rank of fleet admiral in 1944 and represented the United States as signatory of the Japanese surrender document at war's end. He subsequently served as CNO and, upon retirement from the Navy in 1949, as United Nations commissioner appointed to resolve the dispute over Kashmir between Pakistan and India. Nimitz died in San Francisco on 20 February 1966.

Michael S. Casey

See also

Coral Sea, Battle of the; Gilbert Islands; Guadalcanal; Guam, Battles of; Halsey, William F.; Iwo Jima; King, Ernest J.; Leyte Gulf, Battle of; Midway, Battle of; Yamamoto, Isoroku

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Nishizawa, Hiroyoshi (1920–1944)

Imperial Japanese Navy warrant officer and leading ace. Hiroyoshi Nishizawa was born on 27 January 1920 in Nagano Prefecture. He joined the navy in June 1936 and completed flight training in March 1939.

Just before the outbreak of war, Nishizawa was transferred to the Chitose Air Group in the Marshall Islands. When that group was moved to Rabaul in February 1942, Nishizawa was transferred to the 4th Air Group, also on Rabaul, and got his first victory on 3 February 1942 with that group.

In April 1942, the Tainan Air Group, which included aces such as Saburo Sakai and Toshio Ota, was transferred to Rabaul, and Nishizawa was transferred to the 2d Squadron of that air group. From April to November, Nishizawa recorded 30 air victories with as many as six victories in a single battle.

On 25 October, Nishizawa's aircraft was damaged in battle and he was forced to land on Cebu Island. He boarded a transport on 26 October for the return to Luzon, where he was based. The transport was intercepted over Mindoro Island and shot down, killing all aboard.

Nishizawa was Japan's leading ace of World War II, with estimated total kills ranging from 86 to more than 150 aircraft.

David A. Pluth

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Nonlethal Weapons

A class of weaponry that incapacitates personnel and materiel while minimizing fatalities, permanent injury to personnel, and undesired damage to property and the environment. Unlike conventional weapons, nonlethal weapons do not rely upon blast, fragmentation, and penetration for their effects but instead utilize other means to stop their target from functioning. These weapons range from mechanical and kinetic devices to chemical compounds, biological organisms, and various forms of directed energy. From an airpower perspective, the more exotic of these weapons offer strategic-paralysis and mass-disruption capabilities. In the Vietnam War, emulsifying agents were thought to be air-dispersed over the Ho Chi Minh Trail by the United States in an attempt to degrade the logistical lifeline of Vietcong forces. Low-energy lasers were reportedly used by British naval forces in a counteroptical role against Argentine aircraft during the Falkland Islands War. During the Gulf War, carbon fiber–filled cruise missiles were said to be used by the United States against Iraqi power plants that resulted in their temporary shutdown.

Robert J. Bunker

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Normandie-Niemen Regiment

Free French fighter unit during World War II. The Normandie Squadron was organized in Syria in September 1942 from Free French pilots impatient to fight the Germans. After training in Russia, they entered combat under the command of Jean Tuslane on the Western Front on 22 March 1943 and were assigned to the 303 IAD (Fighter Aviation). They flew for the rest of the war in Russia and expanded to an overstrength regiment. In June 1944, the Soviet government awarded them the honorific title Niemen for distinguished combat at that river. Initially equipped with the Yak-1 fighter, they later received the Yak-9 and in 1944 the Yak-3. Their last commander was Louis Delfino. They flew 4,534 combat hours and fought 869 air combats, scoring 273 victories in exchange for 42 pilots killed or missing. Fourteen pilots scored 10 or more victories, and the top ace was Marcel Albert, who scored 22 victories in Russia and one in France in 1940. The French and Russian governments each retain an air unit perpetuating the lineage and traditions of the Normandie-Niemen Regiment.

George M. Mellinger

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Normandy, Task Force

Coalition force that spearheaded the Gulf War's major offensive. At approximately 11:38 P.M. Greenwich Mean Time on 16 January 1991, eight U.S. AH-64A Apache attack helicopters from the 1st Battalion, 101st Aviation Regiment, 101st Airborne Division, fired the first shots of the war, a salvo of Hellfire missiles onto two radar facilities in south-central Iraq north of the Saudi Arabian border. This element—Task Force Normandy, named in honor of the men from the 101st Airborne Division who led the Allied invasion of France on D-Day five decades earlier—was under the direct command of Lieutenant Colonel Richard A. "Dick" Cody, an innovative U.S. Army aviator. The attack's purpose was to silence the radar facilities, denying the Iraqis early detection of U.S. aircraft penetrating Iraqi airspace en route to strategic targets in and around Baghdad.

The Apaches used on the raid were configured in such a way as to make the mission feasible and achievable. Remote ground-refueling operations were necessary because of the long distances involved. Lieutenant Colonel Cody proposed using the AH-64A in a slightly modified configuration. In place of one rocket pod capable of carrying 19 2.75-inch folding-fin aerial rockets, each of the eight aircraft selected for the mission carried one 230-gallon auxiliary fuel tank. Remaining armament included 19 rockets, eight Hellfire missiles, and approximately 1,000 rounds of 30mm high-explosive rounds. In this configuration, the Apaches were set up to fly the mission without an intermediate refueling requirement and deliver sufficient ordnance on the targets to ensure their destruction.

On 17 January 1991 at approximately 12:01 A.M. in Saudi Arabia, Task Force Normandy departed Al Jouf, crossed the border into Iraq, and proceeded along northerly routes as two separate teams in the direction of the radar sites, which were separated by about 40 miles of open desert. At precisely 10 seconds prior to the prescribed engagement time, the mission commander gave the signal to the other aircraft to stand by for missile launch, breaking radio silence for the first time since before departing Al Jouf. At 2:38 A.M. local time in Saudi Arabia, eight missiles—four per radar site—impacted their targets. In all, several dozen missiles were fired, first at the power-generating equipment, then immediately on the radar dishes, command-and-control vans, and antennae simultaneously. After a distant engagement using missiles, the aircraft proceeded to within a half-mile of their targets, engaging all the way with rockets and 30mm rounds. The radar facilities had been immediately disabled and, within only a few moments, completely destroyed.

By midafternoon on 17 January, all but one mission aircraft had returned safely to their home base at King Fahd International Airport. The eighth Apache, along with the logistics aircraft, had remained at Al Jouf to address some main rotor damage caused by flying debris or small-arms rounds from Iraqi sentries. Within 24 hours, however, those aircraft also returned to King Fahd International Airport, ready to continue with the task of fighting a war that was now well under way.

The success of Task Force Normandy redefined the U.S. Army's use of attack helicopters and reshaped the battlefield. Apache unit commanders across the Kuwaiti theater began equipping their aircraft with one auxiliary fuel tank on a regular basis as dictated by mission requirements.

Rafael J. Garcia Jr.

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Norstad, Lauris (1907–1988)

U.S. Air Force General Lauris "Larry" Norstad was a fighter pilot, planner, and staff officer. During World War II he served in North Africa, the Mediterranean, and Washington.

After the war, Norstad worked on the Air Staff in Washington until 1950, when he was made commander of United States Air Forces in Europe. Two years later, he was awarded his fourth star—at age 46 the second-youngest American to achieve that rank.

In April 1956, Norstad was chosen as Supreme Allied Commander Europe—the first airman to hold that position. A strategic airpower advocate, he suited the Eisenhower administration, which propounded a strategy of massive retaliation. Over the next six years, he led NATO through a series of major events, including the Berlin Crisis of 1961. More notably, he guided the debate regarding the control and use of nuclear weapons in NATO. Seeing himself as an "international general" more than an American commander, he was out of step with the Kennedy administration that took office in 1961. Relations deteriorated, and in 1963 Norstad was forced into retirement. He served as CEO of Owens-Corning Fiberglass Corporation for a number of years before retiring again in 1973.

Phillip S. Meilinger

See also

North Atlantic Treaty Organization; U.S. Air Forces in Europe

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North African Campaign

Although Benito Mussolini's Regia Aeronautica attacked the British bastion of Malta in early June 1940, the aerial war in North Africa took a long time to develop, despite skirmishing with Royal Air Force planes flying from bases in Egypt. Initially the small Italian air force in North Africa included only 84 modern bombers, including the Savoia-Marchetti SM 79 Sparviero. It also possessed 144 obsolescent fighter aircraft, such as the durable Fiat CR 42 Falcon biplane. A miscellany of approximately 100 other aircraft rounded out the force.

What subsequently became the RAF's Western Desert Air Force was, if anything, weaker still. It constituted a scratch force of castoffs from imperial service augmented by a few machines just being sent out from the home islands. The latter included, in late 1940 and early 1941, the first arrivals of Hawker Hurricanes (Mk.Is and, later, Mk.IIs). They complemented the few Westland Lysander liaison/reconnaissance aircraft, Bristol Blenheim twin-engine bombers, and venerable Gloster Gladiator biplane fighters with which the RAF defended the Nile Delta.

The arrival of the German Afrika Korps in North Africa in early 1941 altered matters. Accompanying the German ground forces were Luftwaffe units equipped with Messerschmitt Bf 109 single-engine and Bf 110 twin-engine fighters and fighter-bombers. The ground attack role was ably filled by the veteran Junkers Ju 87 Stuka dive-bomber. Italy also reinforced its squadrons with small numbers of agile (and elegant) Macchi-Castoldi MC.202 Folgore single-engine fighters. These aircraft helped carry Italo-German forces to a string of successes in 1941. In mid-1942, they played a positively decisive role in the Axis victories at Bir Hakim and Tobruk.

In the fall of that year, however, factors beyond North Africa's shores began to impede reinforcement of Italo-German forces in the theater. Axis armies and air forces in Egypt were at the end of their logistical network, and precious little fuel, replacement aircraft, and spare parts reached them. By contrast, British armies and Allied air forces in Egypt went from strength to strength, particularly with the activation of the U.S. Army Middle East Air Force's Desert Air Task Force (DATF), consisting of RAF and USAAF fighter and light and medium bombardment groups. Operating, among others, Curtiss P-40 Warhawks ("Tomahawks" and "Kittyhawks" in British and imperial service), and North American B-25 Mitchell and Douglas DB-7 Boston twin-engine bombers, these formations supplied critical air support in defeating the last-ditch Axis effort at Alam el Halfa (31 August–6 September).

At El Alamein as well (24 October–4 November), the DATF helped break the back of Axis resistance to the British Eighth Army's offensive. The early simultaneous landings of Operation TORCH (7 November) brought into northwest Africa what would become the U.S. Twelfth Air Force. Axis forces were now caught in a strategic vise.

From December 1942 to May 1943, Allied airpower grew in strength. Nevertheless, Axis air forces fought on grimly in the struggles of the Tunisian bridgehead. Using all-weather airfields around Tunis and Bizerte, they contested Allied advances as much as their increasingly limited logistics would permit and were especially effective at the turn of the year when Allied planes were either too far from the front or operated from inadequate bases.

The weight of numbers told, however. By early spring 1943, the Luftwaffe and Regia Aeronautica existed as mere remnants in Tunisia. Furthermore, they suffered appalling losses of transports and aircrews to marauding Allied fighters and light bombers in a desperate attempt at aerial reinforcement. The remaining Axis air and ground forces surrendered on 13 May 1943.

D. R. Dorondo

See also

Alam el Halfa, Battle of; El Alamein, Air Battles of; Malta, Siege of; Regia Aeronautica (World War II); TORCH

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North American Aerospace Defense Command (NORAD)

Joint U.S.-Canadian command responsible for the air and space defense of North America. Defense cooperation had been close between these two neighbors since the August 1940 formation of the Permanent Joint Board on Defense. In 1951, Royal Canadian Air Force liaison officers were first formally assigned to Air Defense Command's headquarters in Colorado Springs, Colorado, and by the mid-1950s procedures for joint air defense operations in an emergency were well established. Relevant military forces from both nations were now under the operational control of the commander of NORAD, a general from the United States, with a Canadian general as his deputy, a pattern that has continued to the present day.

Virtually simultaneous with the creation of NORAD was the dawn of the ICBM age, signified by the October 1957 Soviet launch of an earth satellite. Though Sputnik foreshadowed NORAD's eventual emphasis on space operations, defense against bomber attack remained a critical mission for years to come. In 1959, the United States approved construction of the hardened underground Combat Operations Center for NORAD, designed to withstand attacks by multimegaton nuclear weapons at least long enough to raise the alert of an attack and, hopefully, long enough to manage the defense against the first wave of bombers that would likely follow an ICBM first strike. Completed in 1965, this structure is buried beneath 1,500 feet of granite deep within Cheyenne Mountain. Defenses against a bomber attack on North America peaked in size in the early 1960s and declined thereafter, as the emphasis gradually shifted to providing early warning of Soviet missile attacks; in 1981 the "Air" in NORAD's name was changed to "Aerospace" in recognition of the increased importance of space operations.

Despite the end of the Cold War, as well as numerous reorganizations of U.S. Air Force commands beneath it, NORAD remains in existence entering the twenty-first century. Its mission has, if anything, expanded (it has become increasingly involved in the U.S. war on drugs), and it promises to play a major role in any future national missile defense system.

David Rezelman

See also

Air Defense Command; Antimissile Defense; Ballistic Missile Early Warning System; Canadian Air Force; Cold War; Continental Air Command; Distant Early Warning; SAGE Defense System; Soviet Aircraft Development and Production; Sputnik; Strategic Air Command; Tactical Air Command

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North American Aviation

Major U.S. aircraft manufacturer and defense contractor. North American Aviation was incorporated in Delaware on 6 December 1928 and was listed on the New York Stock Exchange for the first time in March 1930. The legendary James H. "Dutch" Kindelberger moved the company to Southern California in 1934, occupying a 159,000-square-foot facility that cost $600 a year to rent. With him came two key designers from Douglas Aircraft: Lee Atwood and J. S. "Stan" Smithson.

The company's first aircraft was the NA-16 single-engine trainer that evolved into the BT-9; the first combat aircraft was the BC-1, a derivative of the same airframe. With a world war looming, North American designed and produced such notable aircraft as the T-6 Texan, B-25 Mitchell, and P-51 Mustang. During the five years of wartime production, North American built 41,000 aircraft; in fact, between 1935 and 1967 manufactured more military aircraft than any other U.S. contractor. At the end of the war, North American employed more than 91,000 people; within months the workforce dropped below 5,000 as war contracts were cancelled and the nation demobilized.

After the war, North American built the AJ Savage bomber for the Navy and the first U.S. jet-powered bomber, the B-45 Tornado, for the Air Force. More important, North American developed the F-86 Sabre, the first operational U.S. swept-wing fighter that went on to great fame in the skies over Korea. Other postwar aircraft included the F-82 Twin Mustang and F-100 Super Sabre for the Air Force, the

Designed as an air superiority fighter, the North American F-100 Super Sabre would prove itself as a close support and reconnaissance aircraft in Vietnam. (U.S. Air Force)

A-5 Vigilante for the Navy, the experimental XB-70 Mach 3 bomber prototypes, and the rocket-powered X-15 research airplane.

In the late 1940s, North American formed a missiles division that experimented with ballistic and guided missiles, eventually producing the X-10 demonstrators, SM-64 Navaho prototypes, and GAM-77 Hound Dog cruise missile used on the B-52. North American's Space and Information Systems Division built the Apollo spacecraft that took men to the moon, and it eventually won the contract to build the Space Shuttle orbiters.

Dennis R. Jenkins

North American B-25 Mitchell

One of the best medium bombers of World War II. The B-25, though close to the company's NA-40 and NA-62 of the previous year, was ordered into production in 1939 without a prototype. The Mitchell was a shoulder-wing twin-engine aircraft with a twin rudder and could carry about 3,000 pounds of bombs. The first flew on 19 August 1940—a year and a week after the order—and 25 had been delivered by the end of 1940. Sixteen B-25Bs took part in the famous April 1942 raid led by Jimmy Doolittle against Japanese cities, taking off from a Navy aircraft carrier 800 miles out in the Pacific. As with most wartime models, constant improvements were introduced: A models added armor, the B powered turrets, the C an autopilot and uprated engines, the G a 75mm cannon for antishipping missions, and the H even heavier firepower. The B-25J was the most numerous, with nearly 4,400 of the 9,800 total B-25s when production stopped in August 1945. In July 1945, a B-25 crashed into New York City's Empire State Building in heavy fog. The Mitchell remained operational in subsidiary roles with the U.S. Air Force until 1960 and for much longer in many other nations.

Christopher H. Sterling

See also

Doolittle, James H.; Mitchell, William; North American Aviation

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North American B-45 Tornado

The first production all-jet bomber in the United States Air Force. Design development began in 1944, and the first prototype flew in March 1947. The Tornado was a straight-wing design with four jet engines, two in a single nacelle under each wing. The crew of four included the pilot and copilot in tandem under the canopy, a navigator-bombardier in the lower nose, and a tailgunner.

In November 1948, the USAF accepted initial delivery to an operational unit, the 47th Bombardment Group, Barksdale Air Force Base, Louisiana. Subsequently, the 47th Bombardment Wing was assigned to Langley AFB, Virginia, and then Royal Air Force Station Sculthorpe in May 1952. The 47th Bombardment Wing with its B-45As provided the first tactical nuclear delivery capability for the theater commander in Europe. The B-45 was modified for delivery of atomic weapons under the Backbreaker program. The Air Force procured 96 B-45As and 10 B-45Cs, which were improved by the addition of wing tanks and aerial refueling for extended range.

The last production version of the Tornado was the reconnaissance variant, the RB-45C. The RB-45C was assigned to strategic and tactical reconnaissance units, conducting combat operations during the Korean War and flying reconnaissance missions over Soviet and other communist countries during the early 1950s.

The USAF retired the B-45 from operational service in 1958. The B-45A had a maximum speed of 496 knots, a combat radius of 463 nautical miles, and a maximum payload of 22,000 pounds.

Jerome V. Martin

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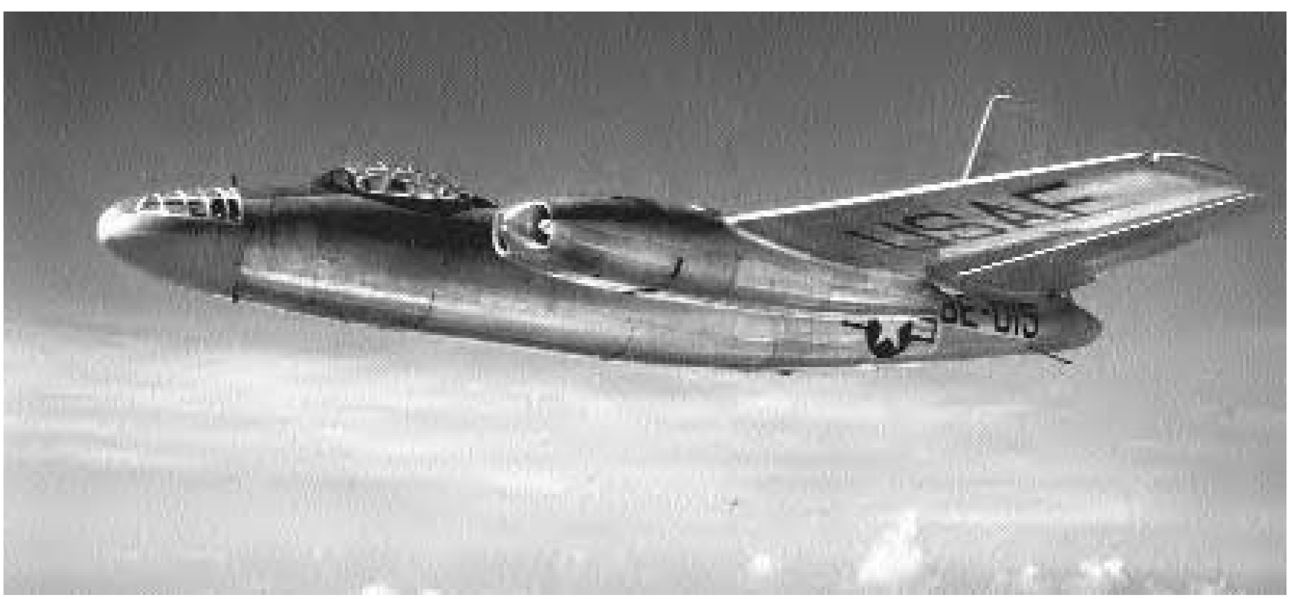
North American B-70 Valkyrie

Experimental high-speed bomber developed for the U.S. Air Force. In 1954, Strategic Air Command commander General Curtis E. LeMay put forth a requirement for an advanced bomber with the highest speed and altitude possible. Both Boeing and North American were awarded development contracts for what was then known only as Weapon System 110. After a hard-fought competition between the two firms, in late 1957 North American got the nod to proceed on the



The first operational jet bomber of the U.S. Air Force was the North American B-45. It served well in the reconnaissance role. (Walter J. Boyne)

WS-110 program. After this, the WS-110 air vehicle was designated B-70 and named Valkyrie.

The Valkyrie was to be a very-high-speed, very-high-altitude bomber intended first to supplement and then to replace the Boeing B-52 Stratofortress during the 1965–1975 period. It was to cruise at speeds exceeding 2,000 mph (Mach 3) at heights above 80,000 feet.

During the B-70's development, on 1 May 1960, Francis Gary Powers's Lockheed U-2C was shot down while overflying Russia. That action, in addition to the advent of operational ICBMs, began to change U.S. defense policy for manned bomber aircraft missions. It had become obvious that Russian defenses could meet and defeat high-flying aircraft. Thus, instead of flying high and fast, it was decided to fly low and slow.

In 1962, the B-70 was canceled as a weapons system. Only two examples were built, as research aircraft for the U.S. Supersonic Transport program and designated XB-70A.

The first XB-70A made its maiden flight on 21 September 1964; the second flew for the first time on 17 July 1965. Both aircraft achieved their maximum performance goals of Mach 3 on their seventeenth flights (respectively, on 14 October 1965 and 3 January 1966). The highest speed and altitude reached: 3.08 Mach and 74,000 feet.

On its forty-sixth flight on 8 June 1966, XB-70A number-two was lost in a midair collision with a NASA F-104 chase plane. Both the copilot of the XB-70A, Major Carl S. Cross, and the pilot of the F-104, Joseph A. Walker, died in the mishap.

The last remaining XB-70A flew on until flight number 83 on 4 February 1969, during which it was ferried to the U.S. Air Force Museum at Wright-Patterson AFB, Ohio.

In all, the two XB-70A Valkyrie aircraft flew 229 times. They remain the largest and heaviest aircraft to have flown at such heights and speeds.

Steve Pace

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North American F-86 Sabre

The first production U.S. aircraft to take full advantage of German World War II research into swept wings. The original design for the new high-speed pursuit plane had been approved with straight wings, but on 1 November 1945 the Air Force approved a plan to incorporate a wing and empennage swept back 35 degrees. The XP-86 made its maiden flight at Muroc, California, on 1 October 1947; the first production aircraft followed on 20 May 1948. Extensive testing was conducted before the new fighter was declared operational, and shortly thereafter the aircraft entered combat in the skies over Korea.

The actual aerial combat statistics for the F-86 have been revised several times as additional information has been declassified, and although the current numbers are not as great as originally believed, the F-86 went on to establish an outstanding reputation as an air superiority fighter. The top ace of the conflict, Captain Joseph McConnell Jr., had 16 victories in the F-86, followed by Captain James Jabara with 15. Other models were optimized for interception duties and even ground attack (including tactical nuclear strike), but most people remember the simple F-86 day-fighter.

No less than 26 countries eventually used the F-86, and Australia, Canada, and Japan set up production lines to produce the aircraft. Both the Australian and Canadian aircraft used indigenously produced engines instead of the General Electric engines that powered most other Sabres. Taiwan used F-86s, including some reconnaissance models, during the 1958 dispute with Mainland China over several islands; this combat resulted in the first operational use of the AIM-9 Sidewinder missile on 24 September 1958. The last F-86 rolled off a production line in Japan in February 1961. And the type served front-line units of several air forces until the late 1960s and second-line units well into the 1970s.

Dennis R. Jenkins

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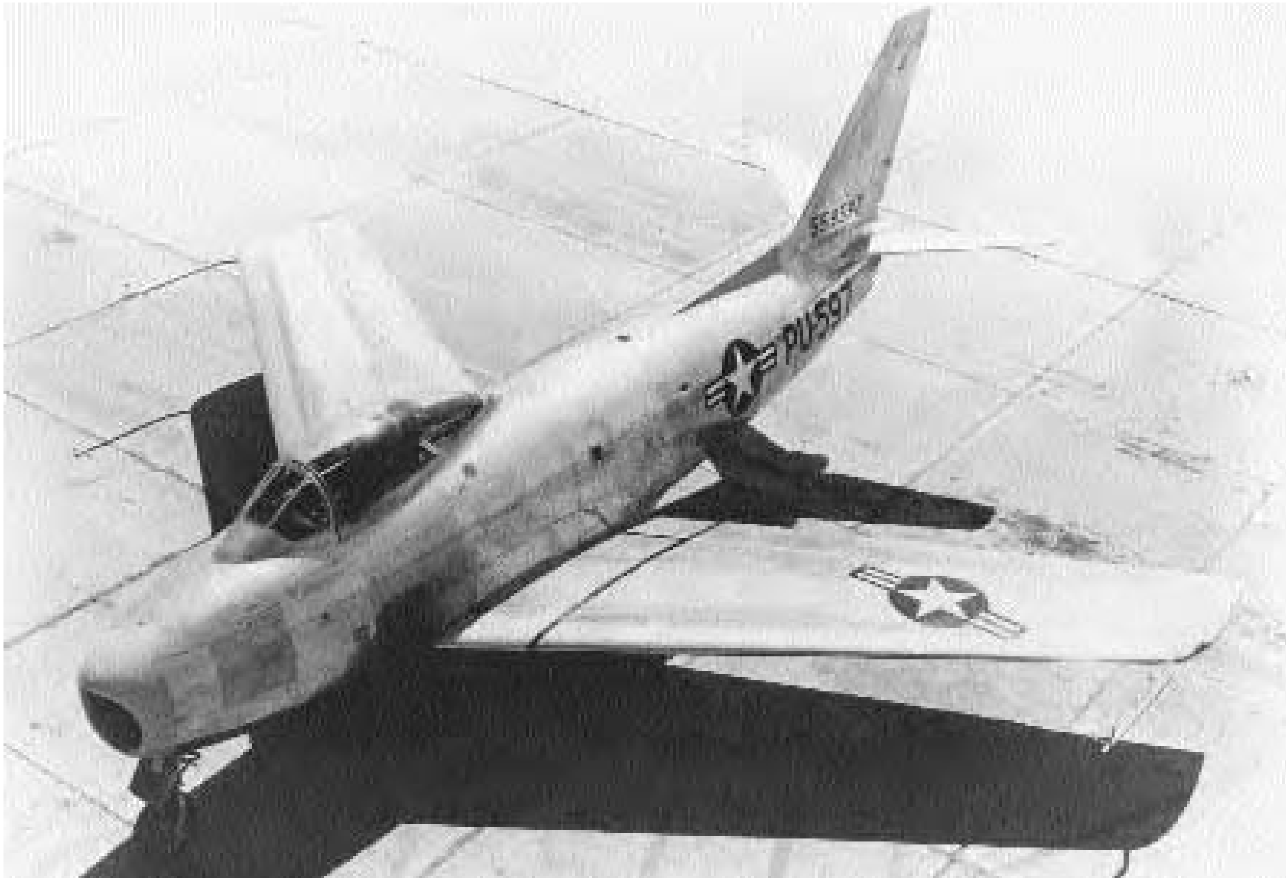
North American OV-10 Bronco

Twin-engine high-wing square-tailed aircraft that saw extensive combat with the United States Air Force, Navy, and Marines in the Vietnam War. Built by North American Aviation at its Columbus, Ohio, plant in the 1960s, the OV-10 was the result of a study done by the Marines that proposed an observation aircraft able to "live" in the field with the troops it was to support and optimized for light strike and forward air control (FAC) duties. Seeking a new aircraft for counterinsurgency as well as FAC duties, the Air Force also backed the concept.

As designed and delivered beginning in late 1967, the OV-10 was powered by two Garrett Air Research turboprop engines. It was equipped with ejection seats for two crewmembers in a long tandem cockpit with bubble canopies that afforded excellent visibility. Onboard radios



The XP-86 was a combination of North American's traditional engineering and design excellence, sweetened by the swept-wing fruits of captured German aeronautical knowledge. (U.S. Air Force)

were totally compatible with all services, and the aircraft was capable of carrying a wide range of ordnance.

In 1968, the aircraft was delivered to U.S. units in Southeast Asia. Eventually, several dozen saw combat duty while assigned to U.S. Marine Observation Squadrons VMO-1, VMO-2, and VMO-6. These three units provided direct support to the 1st and 3d Marine Divisions in northern South Vietnam. New aircraft were also delivered to the U.S. Air Force 504th Tactical Air Support Group and its subordinate squadrons. These aircraft ranged over the breadth and depth if Southeast Asia, from the Plain of Jars and Ho Chi Minh Trail in Laos, to the battlefields of South Vietnam, to the coasts of southern Cambodia.

In 1971, 15 aircraft were specially modified to carry laser designators for the precision placement of laser-guided bombs (Pave Nails), the forefront of the precision-weapons revolution. One OV-10 forward air controller, Captain Steven Bennett, was posthumously awarded the Medal of Honor for his actions near Quang Tri, South Vietnam, on 29 June 1972. The U.S. Navy also had a squadron of OV-10s in South Vietnam (VAL-4, the "Black Ponies"). They specifically worked with riverine and special forces units in the Mekong Delta.

With the cessation of U.S. involvement in Southeast Asia, most OV-10 units were disbanded and the aircraft transferred to other units in Korea, Europe, and the United States. The U.S. Marines deployed OV-10s to combat once again during Operation DESERT STORM. In that conflict, two were shot down; the four crewmen either captured or killed. Subsequently, all remaining OV-10s were removed from active service.

Although no longer used by U.S. military forces, OV-10s are still actively used by the air forces of Thailand, Colombia, and Venezuela.

Darrel Whitcomb

North American P-51 Mustang

One of the best-performing fighters of World War II. The P-51 began as an attempt to meet an April 1940 British Purchasing Mission specification. Though it was rapidly built—the prototype was completed 117 days after the go-ahead—power plant problems delayed the first flight until 26

One of the most famous photos of one of the world's most famous fighters, the North American P-51 Mustang. (U.S. Air Force)

October 1940. The first production models (the NA-73) arrived for British squadrons in 1941. Restricted to tactical work by limitations in the Allison engine, the Mustang (as the British named it) still resulted in more than 600 orders. Many were used in photoreconnaissance.

With installation of the Merlin engine, however, the Mustang reached 440 mph at nearly 30,000 feet; mass production for the U.S. Army Air Forces resulted in nearly 4,000 of the B and C models alone. The D model introduced the bubble canopy; nearly 8,000 were built. More than 500 of the H model and 1,500 of the K model followed, for a total of nearly 15,400 Mustangs built before V-J Day. The fighter was employed in virtually every theater of the war, generally outclassing whatever the enemy could put up against it. The type remained in service with some Latin American air forces into the 1960s. A number also became postwar racing aircraft.

Several hundred of the closely related P-82 (later F-82) Twin Mustangs were built late in and after the war as night-fighters and long-range escorts; some were among the first U.S. aircraft involved in the Korean War in 1950. A tandem-seat version of the aircraft was offered for use in 1967 as a counterinsurgency aircraft.

Christopher H. Sterling

See also

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North American T-6 Texan

Two-place piston-engined transition trainer; bridged the gap for new pilots between basic trainers and higher-performance first-line tactical aircraft.

An evolution of North American Aviation's BC-1 basic trainer, the AT-6 (later designated T-6) first flew in 1939. It featured retractable landing gear, an enclosed cockpit, a variable-pitch propeller, and strong aerobatic performance. It performed all manner of training, at times carrying fixed forward-firing machine guns, flexibly mounted armament in the rear cockpit, and bombs or rockets under the wing. With such diversity, the T-6 provided sound tactical training in both air-to-air and air-to-ground environments while having lower operating and maintenance costs than a front-line fighter.

In spite of having been designed as a trainer, the T-6 was pressed into front-line combat service as a forward air control platform in Korea. The Texan had a much longer loiter capability than the early jets and, once outfitted with an adequate tactical communications system, proved ideal in this role as well.

Eventually operated by 34 nations around the world, the T-6 acquired various names, including Texan (U.S. Army Air Forces), SNJ (U.S. Navy), and Harvard (Royal Air Force). Although retired from active military service, many T-6s still fly at the hands of civilian pilots. The famous Reno Air Races feature a competition dedicated exclusively to the type.

Braxton Eisel

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North American X-15

Rocket-powered research aircraft. The X-15 provided hypersonic data on stability and control during atmosphere exit and reentry, aircraft performance, shock interaction, materials, skin friction, aerodynamic heating, pilot physiology, and energy management. Twelve research pilots from NASA, North American Aviation, the Air Force, and the Navy flew three different X-15 aircraft from 1959 to 1968.

Although the number-two aircraft was later modified, the basic X-15 was a single-seat, midwing monoplane designed to explore the areas of high aerodynamic heating rates and other problems relating to hypersonic flight (above Mach 5). It was powered by rocket engine (initially two XLR-11s, then an XLR-99).

North American's Scott Crossfield, who had helped with the design of the aircraft, made the first unpowered flight on 8 June 1959 and the first powered flight on 29 September 1959. On 22 August 1963, NASA pilot Joseph A. Walker achieved an unofficial world altitude record of 354,200 feet (67 miles) in X-15 No. 3. Air Force Major William J. Knight followed this up with an unofficial world speed record of Mach 6.7 (4,520 mph) on 3 October 1967 in X-15A-2 (modified from the original No. 2 aircraft). NASA's William H. Dana was the pilot for the final flight in the program on 24 October 1968. All of these flights took place within what was called the "High Range" surrounding Edwards Air Force Base, California, and NASA's Flight Research Center (later called the NASA Dryden Flight Research Center).

More important than the records were the more than 765 research reports from the program and the data they contributed to the nation's space program, the Space Shuttle, and any future hypersonic aircraft that may emerge. More intangible but no less important, the X-15 project led to the acquisition of new knowledge about manned aerospace flight by many government and industry teams. They had to learn to work together, face unprecedented problems, come up with solutions, and make this first manned aerospace project work. These teams constituted a critical national asset in the ensuing space programs.

J. D. Hunley

See also

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North Atlantic Treaty Organization (NATO)

Mutual defense alliance currently containing 19 members from Western Europe and North America formed after World War II to offset the substantial military advantage possessed by the Soviet Union. The new organization was intended to be a military alliance capable of deterring the threat posed by the Soviet military.

The original members of NATO, founded on 4 April 1949, were: Belgium, Canada, Denmark, France, Iceland, Italy, Luxembourg, the Netherlands, Norway, Portugal, the United Kingdom, and the United States. Over the next 50 years, NATO expanded to include Greece and Turkey (1952), West Germany (1955), Spain (1982), and the Czech Republic, Hungary, and Poland (1999).

Although NATO forces were always assumed to be better-equipped and -trained, the huge numerical advantage possessed by the Soviet Union and Warsaw Pact militaries meant that Western European security rested partly on the deterrent effect of U.S. nuclear retaliation. Additionally, another important element in the NATO defense of Western Europe was the superiority of Western airpower.

The collapse of the Soviet Union in 1989 opened a new chapter in NATO's history when for the first time it authorized military action outside of its mandate. In April 1993, NATO warplanes began patrolling the skies over Bosnia and later began air strikes against Serbian military targets.

In 1998, the Serbian province of Kosovo, with its Albanian majority, threatened secession, leading to widespread Serbian persecution of civilians. NATO responded with a controversial 78-day bombing campaign, forcing Serbian leaders to capitulate. For supporters of airpower this event was touted as an example of the potential for precision air strikes.

Craig T. Cobane

See also

Warsaw Pact Aviation

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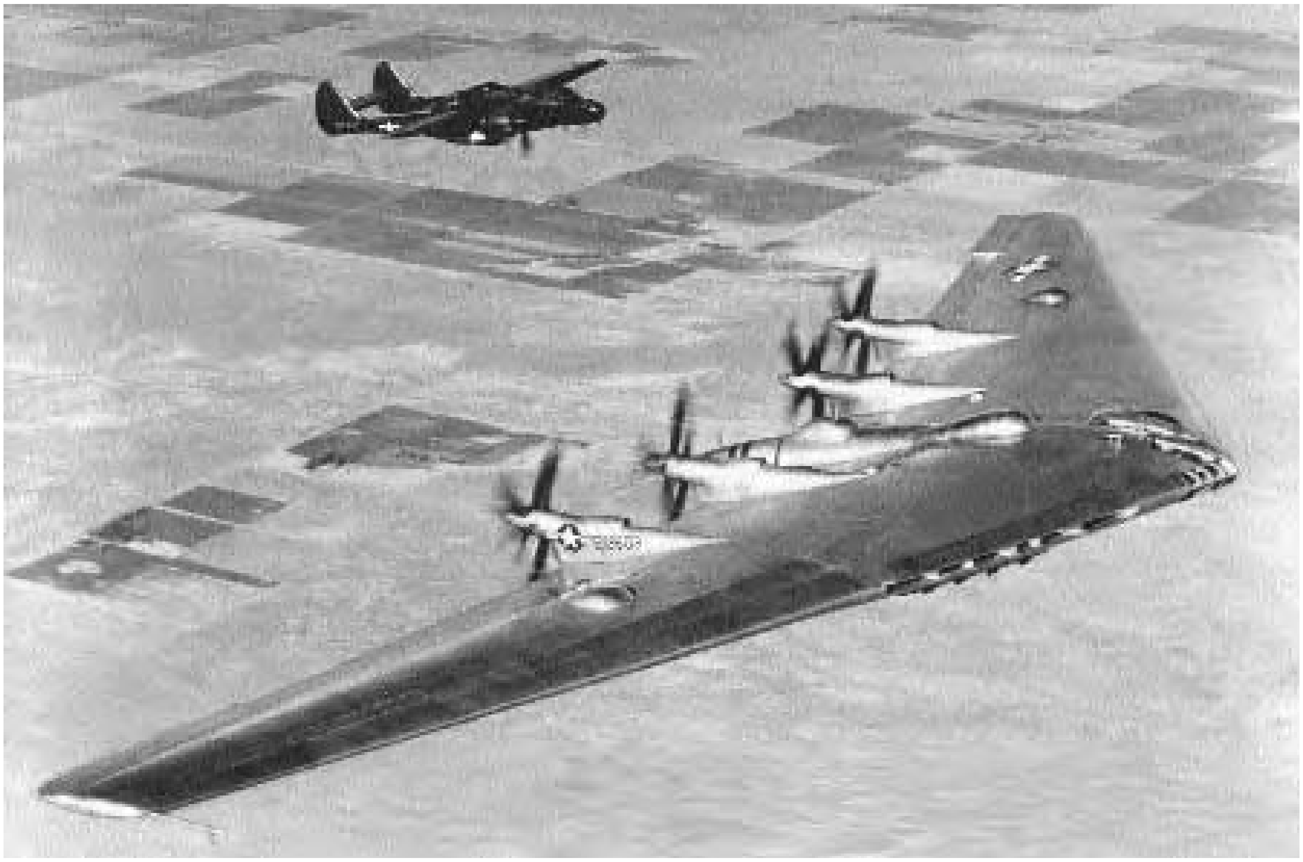
Northrop Aircraft

Major U.S. aircraft manufacturer and defense contractor that completed a merger with Grumman in the mid-1990s. John Knudson "Jack" Northrop (1895–1981) joined the Loughead (later Lockheed) brothers in 1916, then, after brief wartime service, joined Douglas in the 1920s. He returned to Lockheed in 1926 and designed the Vega monoplane. He set up his own firm (Avion) in 1928 and, though it was soon taken over by United Aircraft, served as chief designer. Northrop created the Alpha all-metal seven-passenger monoplane, of which 17 were built. A new Northrop firm was formed as a subsidiary of Douglas in the early 1930s (and was absorbed in 1937). Products included the high-speed Gamma passenger monoplane, of which more than 30 were built.

Yet a third Northrop firm was created in 1939. Its products included the twin-engine P-61 Black Widow, designed as a radar-fitted night-fighter; more than 700 were manufactured. This third firm focused on Northrop's fascination with flying wings (he had built his first in 1929). Several N-9 models laid the groundwork for the piston-engine YB-35 that first flew in 1946. The jet-powered version, the YB-49, flew a year later but, amid great controversy, was canceled in favor of the Convair B-36. The XP-56 took the flying-wing idea into fighters, but only two were built in 1943. The F-89 Scorpion fighter was built to replace the P-61 and first flew in 1948. The F-89D model alone achieved nearly 700 examples manufactured.

Nearly 1,200 T-38 Talon trainers were built between 1959 and 1972. The similar F-5 Freedom Fighter entered service in 1964, and more than 2,600 had been built when produc-

Two of the great men in aviation: John K. Northrop greets General Henry H. "Hap" Arnold. (U.S. Air Force)



A Northrop P-61 Black Widow, a highly successful night fighter, flies chase on the radical Northrop XB-35 Flying Wing. (U.S. Air Force)

tion ended in 1987. An advanced version became the F-20 Tigershark, but the program was canceled short of mass production. The B-2 stealth bomber—the ultimate version of the flying wing concept—first flew in 1989 and 19 of the $1 billion aircraft were placed into service. Northrop was merged into Grumman in 1994.

Christopher H. Sterling

See also

Douglas Aircraft; Lockheed Aircraft; Northrop Flying Wings; Northrop Grumman B-2 Spirit; Northrop T-38 Talon, F-5 Freedom Fighter, and Tiger II

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Northrop Flying Wings

One of the most innovative of the early aviation designs. John Knudson "Jack" Northrop believed that an aircraft should be reduced to its most essential configuration—a flying wing. Early trials began as early as 1929. By July 1940, Northrop had flown the N-1M flying wing, demonstrating that it was possible for an aircraft to dispense with the normal fuselage and empennage. In theory this would allow a significant savings in weight and drag.

Northrop entered a flying-wing design in a U.S. Army Air Corps bomber competition and, on 22 November 1941, was awarded a contract for the prototype XB-35. Four 30-percent scale N-9M models were constructed to test the configuration, and the first XB-35 eventually flew on 25 June 1946. Flight-test results of the two propeller-driven bombers were mixed, but in June 1945 the Army Air Forces directed Northrop to finish subsequent aircraft as YB-49s with eight jet engines. The first YB-49 flew on 21 October 1947, but unfortunately the second aircraft crashed on 5 June 1948, killing Captain Glen W. Edwards (the Muroc test location was renamed Edwards Air Force Base in his honor).

The flying wing continued to demonstrate serious stability and control problems because of its unique configuration and the limitations of the stability-augmentation systems of the era. Although various production contracts were issued for the type, only one more flying-wing bomber would fly—the single YRB-49A reconnaissance prototype. In 1951, the Air Force officially terminated the program in favor of the Convair B-36 and ordered all the remaining airframes destroyed. Proposals for large commercial airliners and cargo aircraft based on the flying-wing concept quietly faded from the scene following the Air Force's decision to cancel the bomber program.

Northrop also proposed flying-wing fighters during World War II, and the small MX-324 and MX-334 were used to validate the basic aerodynamics of the concept. The first of the fighters, the XP-56 Black Bullet, actually used a very small fuselage but did not have horizontal stabilizers and resembled a wing shape more than a traditional aircraft. First flown on 6 September 1943, the aircraft crashed a few weeks later. A second example flew six months later but could not compete with the P-47s and P-51s that were already in production; it quickly faded from sight. Subsequently, three true flying wings (the XP-79) were ordered, although the failure to develop a suitable rocket engine to power them led to the first two being cancelled before they were completed. The third, designated XP-79B, was completed with two jet engines. The aircraft made its first and only flight on 12 September 1945, crashing and killing test pilot Harry Crosby.

By far the most successful Northrop flying wing would come along 30 years later. Begun as a highly classified project during the early 1980s, the first B-2 Spirit stealth bomber made its maiden flight on 17 July 1989. A true flying wing—with no fuselage or empennage—the B-2 is exactly what Jack Northrop tired to create with the XB-35/49. The primary difference is that by the 1980s computers allowed the creation of stability-augmentation systems that could successfully control the unstable shape. Unfortunately, the B-2 proved to be enormously expensive, and production was capped at 21 aircraft, providing the U.S. Air Force with only a single squadron of stealth bombers.

The B-2 bomber has a crew of two pilots—an aircraft commander and mission commander—and flies at about 650 mph. The B-2 has 136 onboard computers, with far more computer power than the Space Shuttle. The B-2 relies on its computers to evade enemy radar defenses, for flight stability, and for many other functions.

Each B-2 can carry nuclear bombs, 40,000 pounds of regular munitions, or a payload of 2,000-pound satellite-guided bombs. Once over the target, these "almost-smart" bombs can hit within several yards of a target.

In the 11 weeks of the air war in Kosovo, six B-2 Spirits flew 45 missions and dropped more than 600 bombs. They were never seen by the enemy or hit by enemy fire.

Dennis R. Jenkins and Henry M. Holden

See also

Northrop Aircraft

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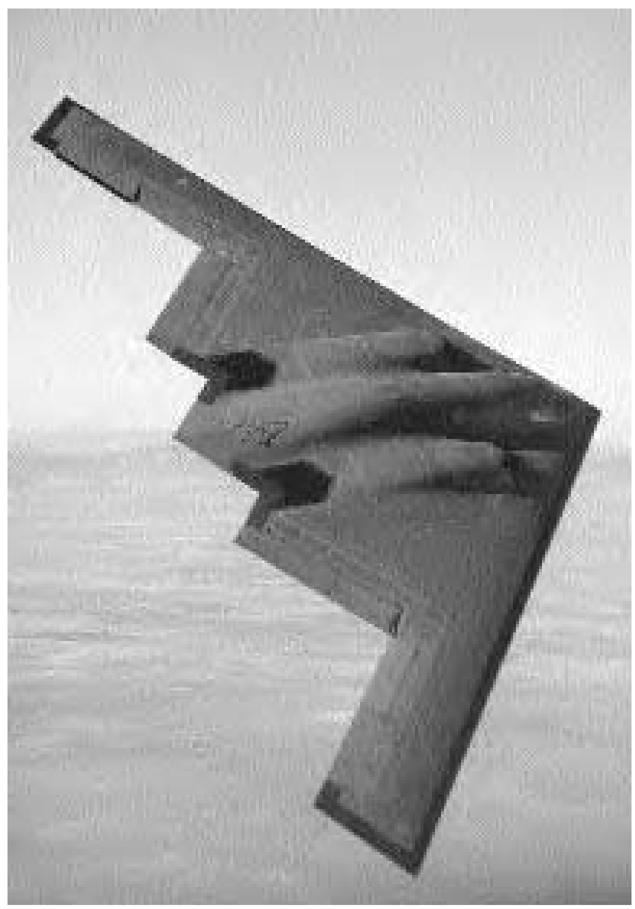
Northrop Grumman B-2 Spirit

The world's first stealth bomber. It is made mostly of a carbon graphite material, which is stronger than steel and lighter than aluminum. This material also absorbs most of the radar energy directed at it. Each one of these four-engine bombers costs about $2 billion to construct.

The B-2 has a crew of two pilots—an aircraft commander and mission commander—and flies at about 650 mph. The B-2 bomber has 136 onboard computers, with far



The Northrop B-2A Spirit stealth bomber has proved itself to be a remarkable long-range weapon in the war on terrorism. (U.S. Air Force) more computer power than the Space Shuttle. The B-2 relies on its computers to evade enemy radar defenses, for flight stability, and for many other functions.

Each B-2 bomber can carry nuclear bombs, 40,000 pounds of regular munitions, or a payload of 2,000-pound satellite-guided bombs. Once over the target, these semi-smart bombs can hit within several yards of a target.

During the 11 weeks of the air war in Kosovo, six B-2 Spirits flew 45 missions and dropped more than 600 bombs. They were never seen by the enemy or hit by enemy fire. They also distinguished themselves in the action in Afghanistan.

Henry M. Holden

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Northrop T-38 Talon, F-5 Freedom Fighter, and Tiger II

During the mid-1950s, the U.S. Air Force required a trainer with higher performance than the Lockheed T-33 to better prepare student pilots for the latest tactical aircraft that were then coming into service. The aircraft chosen was the T-38A, which offered high performance with low maintenance and operating costs. The T-38A became the Air Force's first supersonic trainer. The T-38A prototype first flew on 10 April 1959, and production continued until 1972. A total of 1,189 T-38As were built, and a small number were later modified into AT-38Bs with external armament for weapons training. Jacqueline Cochran set eight performance records in the fall of 1961 flying a production T-38A, and in February 1962 a T-38A set four international time-to-climb records. The Air Force Thunderbirds aerobatic team used T-38As from 1974 to 1982 because of their economic operation and high performance. Other users of the T-38A have included the U.S. Navy in their Top Gun program and NASA as astronaut-proficiency trainers. Approximately 562 remain in service throughout the Air Force. An ongoing program called Pacer Classic, the structural life extension program for the T-38, is integrating 10 modifications, including major structural renewal, into one process. As a result, the service life of T-38s should extend to 2010.

Based on the development of the T-38, Northrop management decided to use company funds to construct a light fighter variant aimed primarily at the foreign sales market. The development of the resulting N156 continued as a private venture until the Department of Defense issued a contract for three prototypes in May 1958. The first aircraft made its maiden flight on 20 July 1959, but internal disagreements within the defense community delayed a production contract until 22 October 1962. The first production single-seat F-5A flew in October 1963, the first two-seat F-5B on 24 February 1964. The slightly larger and more powerful F-5E and F-5F were introduced in late 1972. In 1979, Northrop decided to use company funds to create a further upgraded model, initial designated F-5G and later F-20 Tiger II. This was a major redesign that replaced the two General Electric J85 engines used by earlier models with a single General Electric F404 turbofan. Although a significant advancement, the F-20 found itself competing with the General Dynamics F-16, and none were sold.

Although it did not have the performance of some of its more costly contemporaries, the F-5 Freedom Fighter was reliable, easy to maintain, and inexpensive. It served only in relatively small numbers with the United States armed forces, first as a trial with the U.S. Air Force in Vietnam, later as an adversary aircraft with all three U.S. military air arms. However, the F-5 was widely exported, with no fewer than 27 countries operating the type, often on a second- or third-hand basis. A total of 1,871 F-5s were built by Northrop, and a further 776 were built under license in Canada, Spain, Switzerland, South Korea, and Taiwan. The F-5 is still an important part of many foreign air forces.

Dennis R. Jenkins

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Norwegian Air Campaign (1940)

Germany invaded Norway on 9 April 1940, after having struck Denmark and seized its two major airfields. The Luftwaffe used the bases to ferry troops and supplies into Norway—the first major airlift of the war. The major port cities of Norway were attacked simultaneously, as was the airfield at Stavanger. These attacks employed approximately 1,000 aircraft—including virtually entire airlift capacity of the Luftwaffe. By the end of the first day all objectives had been accomplished.

In an attempt to liberate Norway, the Allies landed at Trondheim and Narvik. Trondheim, however, was within range of Luftwaffe aircraft, and after two days the Allies realized that without air superiority they would have to evacuate. With its nearest air base more than 600 miles distant, the

RAF could not intervene, and the Fleet Air Arm—equipped with obsolete aircraft such as the Swordfish and Skua—was outmatched. Even if the Allies had been able to recapture Trondheim, they could not have held it in the face of the Luftwaffe. Within a fortnight the Allies evacuated.

The situation at Narvik was not quite as dismal for the Allies because it was so far north even the Luftwaffe had difficulty getting there. The RAF carved three airstrips out of the snow and deployed some aircraft. As a result, Allied ground forces were able to make headway. Unfortunately, on 11 May 1940 the Battle for France began, and before the Allies had even retaken Narvik they were planning its evacuation. It fell on 25 May, but the Allies departed two weeks later. The Germans soon reoccupied it.

The key observation of the campaign was the necessity for air superiority. The Allies hoped that command of the sea would allow them to seize or establish air bases for defense of a lodgment. This was impossible because the Luftwaffe had already achieved air superiority over the littoral. Control of the air determined who would control the surface beneath it.

Phillip S. Meilinger

See also

Fleet Air Arm; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Novikov, Aleksandr Aleksandrovich (1900–1976)

Soviet air force commander during World War II. Aleksandr Aleksandrovich Novikov was born on 19 November 1900 in the Kostroma region of Russia. He fought in the civil war and was trained as one of the new Red Commanders. In 1933, he transferred to the air service. He participated in the Finnish Winter War as Air Chief of Staff, Northwestern Front. In 1940, he was appointed commander of the air forces of the Leningrad Military District, designated the Northwestern Front in June 1941. During the first months Novikov again distinguished himself in defending Leningrad, managing the air bridge that helped the city survive the first winter's blockade.

On 11 April 1942, he was promoted to lieutenant general and appointed commander of the air forces. Novikov's most notable reform involved removing the dispersed air assets from the direct control of ground-forces commanders, reorganizing them into air divisions based on tactical function and concentrating them in newly organized air armies under a commander responsible for coordinating all air activities for the front. He also reformed the training and deployment of replacements. Other tactical and operational reforms included the air blockade of Stalingrad, as well as a more aggressive use of tactical airpower. Six decades later, Novikov's organizational reforms are still almost intact in the Russian air forces.

On 17 March 1943, Novikov was promoted to marshal of aviation and, in February 1944, to chief marshal of aviation. He was awarded his first Hero of the Soviet Union on 17 April 1945 and received a second for his leadership in the Japanese war on 8 September 1945. In February 1946, he was arrested and imprisoned until June 1953, when he was rehabilitated and appointed commander of long-range aviation. He was removed by Nikita Khrushchev in March 1955 as part of the policy favoring missiles over bombers. Novikov died on 3 February 1976.

George M. Mellinger

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Nowotny, Walter (1920–1944)

One of the most successful German fighter pilots who entered service after the start of World War II. Nowotny joined a front-line fighter unit, Jagdgeschwader 54 (JG 54; 54th Fighter Wing) in February 1941 and took part in Operation BARBAROSSA, the German invasion of the Soviet Union, that June. He remained with JG 54 on the northern sector of the Eastern Front until he was grounded in November 1943, after his 256th air victory, for which he became the eighth member of the Wehrmacht to receive the Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross. After a period in a training wing, he was chosen by Adolf Galland to command the unit that would introduce the Me 262 jet fighter to combat. The success of this unit was crucial if the Me 262 was to play the role that Galland envisioned for it in the air defense of Germany. Nowotny scored two victories while flying the jet but was apparently not an especially skillful unit commander, having received no training for this role. Galland was compelled to visit Nowotny's Achmer base to evaluate his performance and, while there on 8 November 1944, witnessed Nowotny crash to his death on the edge of the airfield after a battle with P-51s.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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O

O'Grady, Scott

Downed F-16C pilot who eluded capture by Serbian forces during NATO operations in the former Yugoslavia. On 2 June 1995, Captain Scott O'Grady, assigned to the 555th Fighter Squadron at Aviano AB, Italy, took off as the wingman in a flight of two aircraft. He and his leader, Captain Bob Wright, were on a mission over Bosnia as part of DENY FLIGHT, a huge NATO operation designed to enforce a UN-mandated no-fly zone over northern Bosnia. O'Grady's call sign was "Basher 52."

While on orbit at 26,000 feet just south of the city of Banja Luka, his aircraft was hit and destroyed by a Serbian SA-6 surface-to-air missile. Ejecting, he floated down into an area occupied by Serbian forces and civilians. He quickly hid in a forested area as the enemy personnel furiously searched for him.

For the next five days, NATO aircraft and personnel frantically searched as rescue forces stood by to attempt a recovery. In the early morning hours of 8 June, a fellow F-16 pilot from Aviano made radio contact with O'Grady and initiated a rescue effort.

At the direction of Admiral Leighton Smith, the commander of NATO's southern forces, a rescue task force from the 24th Marine Expeditionary Unit, afloat in the Adriatic Sea aboard the USS *Kearsarge* and other ships, took off to make the pickup.

The task force consisted of a platoon of Marines aboard two CH-53 helicopters, two AH-1W Cobra gunships, two AV-8 Harriers, and almost 40 other support aircraft of all types. This large formation entered Bosnian airspace just as the sun was beginning to rise.

Arriving near O'Grady's location, one of the Cobra pilots made radio contact with him and then spotted his location. The pilot then directed the landing of the two CH-53s. As the lumbering aircraft touched down, the Marines on board quickly disembarked and established a defensive perimeter. O'Grady made a dash for one of the CH-53s. He was quickly pulled aboard, and the security team was recalled. With every Marine onboard, the task force departed.

Now alerted to the action of the NATO forces, Serbian units along the egress route began to react. Numerous enemy troops began firing at the aircraft. Several of the helicopters were hit—all without serious damage to aircraft or injury to personnel. And at one point, several heat-seeking missiles were also fired at the task force. But the Marine pilots were able to successfully evade all of them.

The recovery aboard the USS *Kearsarge* was uneventful. Captain O'Grady was returned to his unit, and the mission was recorded as a complete success.

Darrel Whitcomb

Ohain, Hans Joachim Pabst von (1911–1998)

Recognized as an independent coinventor of the jet engine. Hans von Ohain was born in Dessau, Germany, on 14 December 1911, grew up in Berlin, and received his doctorate in physics from the University of Goettingen in 1935. While a student, he was attracted to problems surrounding aircraft propulsion efficiency and formulated his early concepts concerning gas turbine or jet engines. In 1934, with the help of his dissertation adviser, R. W. Pohl, he began experimental work to explore those theories. Two years later, in 1936, again with help from Pohl, von Ohain found himself working for aviation industrialist Ernst Heinkel. With Heinkel's backing, work on the jet engine proceeded quickly, and on 27 August 1939 the first turbojet-powered aircraft flight was made with von Ohain's HeS.3B propelling Heinkel's He 178 test aircraft into the sky. Von Ohain continued to work for Heinkel throughout World War II.

Following the war, von Ohain was invited to the U.S. under Project Paperclip and was assigned to Wright Field. He remained there for the next 32 years, retiring in 1979 as chief scientist of the Aero Propulsion Laboratory of the Air Force Wright Aeronautical Laboratories. He then entered academia as a professor at the University of Dayton Research Institute, Ohio, and as a visiting professor at the University of Florida.

Stanley W. Kandebo

See also

Heinkel Aircraft; Wittle, Frank

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Wagner, Wolfgang. *The First Jet Aircraft.* Atglen, PA: Schiffer, 1998.

O'Hare, Edward H. (1914–1943)

U.S. Navy fighter ace. Born 13 March 1914 in St. Louis, Edward "Butch" O'Hare was a section leader in Fighting Squadron 3 flying from the carrier *Lexington* when that ship, approaching Rabaul in a raid on 20 February 1942, was sighted by the Japanese. In the first clash between U.S. and Japanese carrier aircraft, O'Hare attacked repeatedly one Japanese formation of nine Nakajima B5N "Kate" torpedo-bombers. Flying a Grumman F4F Wildcat fighter, he made the most of his limited ammunition, shooting down five of the bombers (one of which tried to crash into the *Lexington*) and damaging a sixth. For this gallant and effective action, O'Hare received the Medal of Honor from President Franklin D. Roosevelt.

In the fall of 1943, O'Hare commanded Air Group Six, which was tapped by Rear Admiral Arthur W. Radford for experimental work, code-named BLACK PANTHER, in night-fighter tactics. Flying from the *Enterprise* during Operation GALVANIC, O'Hare on 26 November led two F6F Hellcat fighters and one radar-equipped TBF Avenger torpedo-plane in a risky intercept operation against two Mitsubishi G4M "Betty" bombers. Although the Japanese planes were both downed, so was O'Hare, possibly by friendly fire. Despite an intensive search, no trace of him was ever found. He had, nonetheless, pioneered the way for effective night intercept operations from carriers.

Recommended for a second Medal of Honor, he was awarded the Navy Cross. Among his other honors is the perpetuation of his name by Chicago's O'Hare International Airport.

Malcolm Muir Jr.

See also

GALVANIC; Gilbert Islands; Grumman F4F Wildcat; United States Navy, and Aviation

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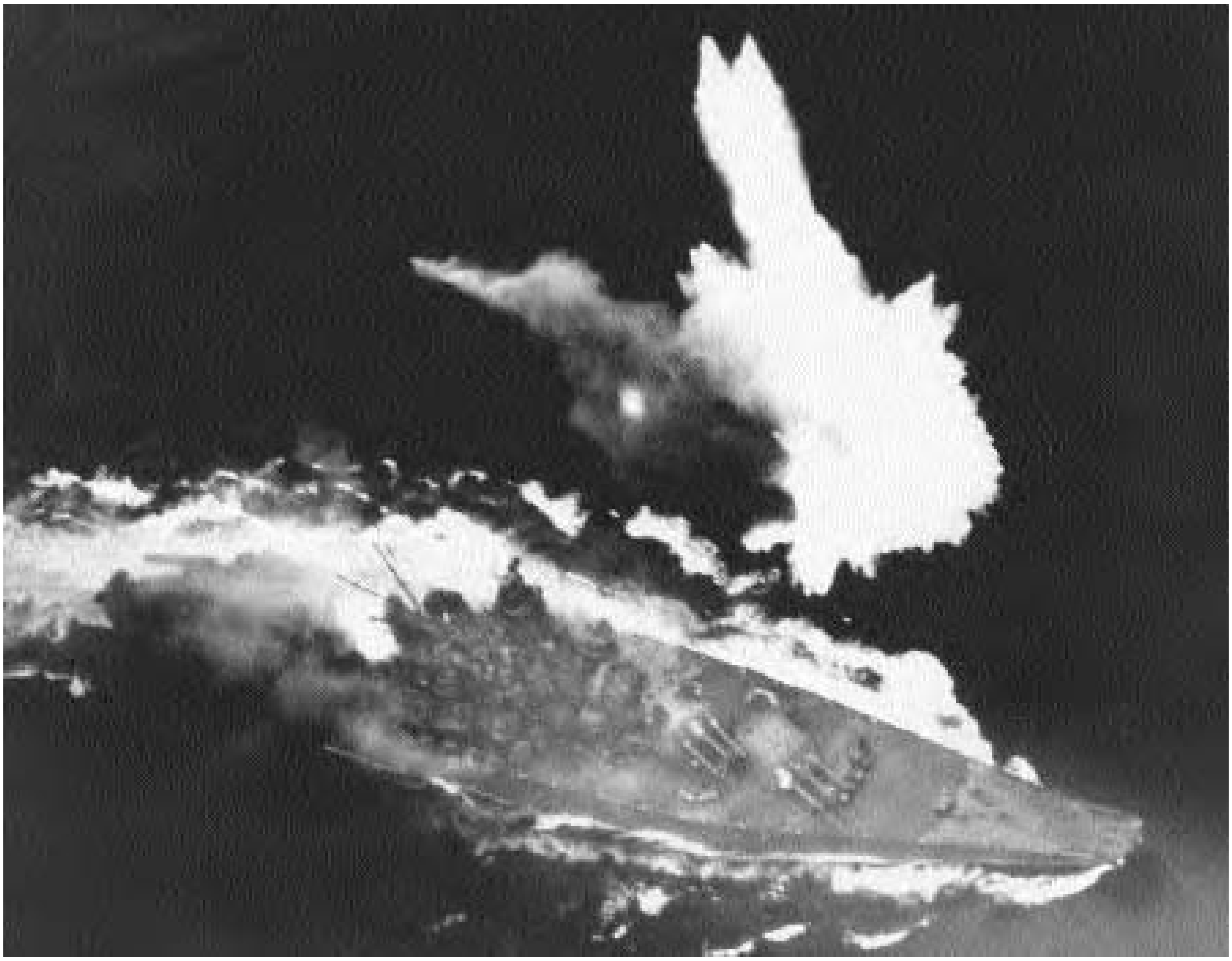
Okinawa

Springboard for an invasion of the Japanese home islands that never occurred. The U.S. Joint Chiefs of Staff, on 25 October 1944, determined to undertake the invasion of Okinawa. By 1944, the Japanese had constructed four major airfields on Okinawa and another on nearby Ie Shima. Okinawa was within striking distance for aircraft operating from Kyushu on the mainland.

When Allied operations commenced, airfields on Iwo Jima were not yet available to provide support. B-29s alone could strike from land bases, but General Henry H. "Hap" Arnold released them from strategic bombing operations only for two preinvasion missions—bombing Kyushu airfields and laying mines. Consequently, naval aviation had to fulfill almost all airpower needs in the operation's early stages.

Task Force 58 raided Japan on 18–21 March. Although the task force inflicted heavy losses on Japanese forces, three of the carriers were forced to withdraw, crippled by kamikazes. The carriers, joined by the British Pacific Fleet, then launched concentrated bombardments of Okinawa and nearby bases to prepare for the invasion. Task Force 58 deployed 11 fleet and six light carriers while BPF had four armored fleet carriers. In total, the carriers operated over 1,400 combat aircraft.

Losses from the Kyushu strikes and a misapprehension of U.S. objectives initially minimized Japanese aerial reaction to the invasion. Nevertheless, Admiral Toyoda contrived a partial concentration of forces in Kyushu and Formosa and initiated Operation TEN-GO on 6–7 April. Almost 700 aircraft (355 kamikazes) attacked the invasion fleet, sinking or damaging 22 vessels. The surface fleet launched its own assault, sending the battleship *Yamato,* escorted by a cruiser and eight destroyers but without any air cover. Task Force 58 intercepted this force on 7 April as it approached. U.S. aircraft attacked almost continuously for more than an hour, sinking *Yamato,* the cruiser, and four destroyers.



It would be nice to think that General Billy Mitchell and Admiral William Moffett were looking down on this scene—the death of the giant battleship Yamato, *on 7 April 1945. It was on a kamikaze mission to Okinawa when it was sunk by naval air power. (U.S. Navy)*

Despite heavy losses, Japanese forces launched nine mass attacks against U.S. forces off Okinawa in addition to less concentrated assaults. A total of 1,465 kamikaze aircraft took part in these mass assaults; a further 450 made smaller attacks. The Japanese navy and army also sent some 3,500 conventional sorties against the invasion fleet. Japanese air attacks sank or damaged no less than 125 U.S. warships, from carriers to landing craft, and hit all the British carriers, plus several smaller vessels, although no Allied carriers were sunk.

As U.S. forces advanced on Okinawa, airfield development became the priority. Marine Corps artillery observation aircraft began operations on 2 April, and Corsairs came ashore five days later. From then on, the Marine Corps aircraft took an expanding role in local air defense and close air support. Army P-47s arrived on 14 May, the first of many AAF units.

The fast carriers departed on 13 June, and air operations became largely the domain of land-based forces, both on Iwo Jima and in the Ryukus. The Okinawa campaign officially ended on 2 July 1945.

Paul E. Fontenoy

See also

British Pacific Fleet; Iwo Jima; Japan, Air Operations Against; Kamikaze Attacks; McCain, John S.; Mitscher, Marc Andrew; Spruance, Raymond A.; Task Force 38/58; Vian, Philip L.

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Olympic Arena/Guardian Challenge

The names of the annual competition for USAF ICBM and space operations units. The competition has several goals, the chief of which is to use competition to enhance crew performance. Secondary goals include encouraging innovation during competition preparation, enhancing esprit de corps, providing a venue to recognize top performers in the command, and enhancing public relations.

Strategic Air Command (SAC) began the competition in 1967 under the name Curtain Raiser. SAC cancelled the competition in 1968 due to its commitments to the Vietnam War, but the competition recommenced in 1969 as Olympic Arena. In 1993, Air Combat Command gained control of USAF ICBMs and hosted the final Olympic Arena.

In 1994, ICBM forces moved to Air Force Space Command, and Olympic Arena was renamed Guardian Challenge. The change reflected that command's motto—"Guardians of the High Frontier"—and the inclusion of space units in four mission areas: space operations, spacelift, space warning, and satellite operations. Over time, the number of participants and mission areas represented at Olympic Arena and Guardian Challenge expanded from the competition's initial focus on operations to include several different types of missile and support equipment maintenance, space equipment maintenance, security forces, helicopter operations, and food-service personnel.

Grant Weller

See also

Missiles, Intercontinental Ballistic; Strategic Air Command; United States Air Force, Organizational History

Onishi, Takijiro (1891–1945)

Japanese vice admiral; early advocate of naval airpower. Unlike many contemporaries, he almost exclusively held aviation billets throughout his career, where he significantly advanced development and deployment of the navy's air arm.

Onishi graduated from the Naval Academy in 1911, served with the navy's first air units during World War I, and studied wartime air combat experience in Britain. Upon returning, he held increasingly important line and staff aviation positions. He forcefully condemned new battleship construction, urging instead carrier primacy and long-range shore-based bomber development.

In 1939, Rear Admiral Onishi became Chief of Staff, Eleventh Air Fleet. He assisted planning of the Pearl Harbor attack and coordinated the devastating air assault on the Philippines. Promoted vice admiral in 1943, he returned to Tokyo, then went to the Philippines in October 1944, commanding the First Air Fleet. There he developed aerial suicide attack concepts and directed the first such operations.

Onishi became vice chief of the navy General Staff in May 1945. He committed ritual suicide on 15 August 1945.

Paul E. Fontenoy

See also

Iwo Jima; Japanese Naval Air Force, Imperial; Kamikaze Attacks; Leyte Gulf, battle of; Netherlands East Indies; Pearl Harbor; Philippines; Yamamoto, Isoroku

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Operations, Military

All military operations are arranged according to their code names (e.g., ALLIED FORCE).

Osirak Nuclear Reactor

Iraqi facility attacked by Israel in the early 1980s to thwart Iraq's acquisition of weapons-grade uranium. Nuclear proliferation in the Middle East has been a steady source of concern for Israel, Arab states, and their superpower supporters. By the late 1960s, most Arab nations took for granted an Israeli nuclear capability and worked to establish their own. With French duplicity, Iraq appeared to have completed this goal by 1980. The Tammuz I reactor at the Osirak nuclear reactor facility at Tuwaitha, near Baghdad, would begin producing weapons-grade plutonium between July and September 1981.

Israel was not the only potential atomic target, as Iraq had been at war with the Islamic Republic of Iran since 1980. Western hostility toward revolutionary Iran meant a blind eye to Iraq's nuclear efforts. Amid seeming indifference from the West, Israel alone viewed the imminent Iraqi nuclear capability as a threat to be eliminated. Consequently, Israeli Prime Minister Menachem Begin decided to act unilaterally to destroy the reactor.

In a spectacular aerial operation on 7 June 1981, the Israeli Air Force launched Operation BABYLON. Eight General Dynamics F-16s and six McDonnell Douglas F-15s flew undetected some 600 miles at altitudes around 100 feet above Saudi Arabia and Iraq. At approximately 4:30 P.M. with the setting sun behind them, the F-15s climbed to 25,000 feet to provide aerial cover for the F-16s as they dropped pairs of conventional 2,000-pound bombs on the complex. Unchallenged by MiGs, the aircraft turned west and returned to Israel without loss. Despite claims otherwise, the F-16s were not refueled during the flight, completing the 1,000-plus mile mission well in excess of the manufacturer's design limits on range. The Iraqi reactor facility was badly damaged. By some assessments, the attack delayed its operation by five years but did not halt it altogether. This proved nettlesome to the West, as fear of potential Iraqi nuclear weapons affected Coalition planning during the 1991 Gulf War.

Robert S. Hopkins

See also

DESERT SHIELD; DESERT STORM; Iraqi Air Force; Israeli Air Force; Israeli-Arab Conflicts; Lockheed Martin F-16 Fighting Falcon

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Ozawa, Jisaburo (1886–1966)

Japanese vice admiral; Japan's principal carrier force commander from 1944 onward. Ozawa graduated from the Naval Academy in 1909 and served in surface vessels until 1937, when he became Chief of Staff of the Combined Fleet. In 1940, he took command of the 1st Carrier Division, then, as a vice admiral, led the Southern Expeditionary Fleet in support of the successful Japanese assault on Malaya and the Dutch East Indies.

Ozawa commanded Japan's main carrier forces, the First Mobile and Third Fleets, at the Battle of the Philippine Sea in June 1944, during which he was outmatched and outfought by Admiral Raymond Spruance and Task Force 58. He then led the remaining Japanese carriers to their destruction as decoys at Cape Engano during the Leyte campaign in October.

Paul E. Fontenoy

See also

Cape Engano, Battle of; Japanese Naval Air Force, Imperial; Leyte Gulf, battle of; Netherlands East Indies; Philippines; Task Force 38/58

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P

Pacific Air Forces

The USAF major command controlling combat forces in the Pacific region and serving as the air component for U.S. Pacific Command (PACOM). Far East Air Forces (FEAF) became Pacific Air Forces (PACAF) in July 1957 when the Joint Chiefs of Staff (JCS) modified the U.S. Unified Command Plan and Far East Command was merged into PACOM. In April 1954, the JCS created a small command element titled Pacific Air Force (note singular) to serve as the air component staff for PACOM, specifically to enhance USAF support in contingency planning and emergency operations. Pacific Air Force was subordinate to Far East Air Forces, and it was briefly redesignated Pacific Air Force/FEAF (Rear) during the transfer of FEAF Headquarters from Japan to Hawaii in 1956 and 1957. Headquarters PACAF was established on Hickam Air Force Base in Hawaii, with primary operational units in Japan, Okinawa, Korea, and the Philippines, as well as two major subordinate organizations: Thirteenth Air Force, headquartered in the Philippines, and Fifth Air Force in Japan.

During the Vietnam War, PACAF was the senior USAF major command in the Pacific region. The initial formal USAF command element in Vietnam was the 2d Air Division (AD) Advanced Echelon (ADVON), activated in November 1961. The 2d AD ADVON was a subordinate organization of PACAF's Thirteenth Air Force, with responsibility for controlling Air Force assets supporting the U.S. Military Assistance Advisory Group Vietnam (MAAG). When MAAG became the U.S. Military Assistance Command Vietnam (MACV), a subunified command under PACOM, in 1962, 2d AD became the air component. The 2d AD controlled USAF operations within South Vietnam; USAF operations outside South Vietnam remained under the control of Thirteenth Air Force and PACAF. To better support expanded operations in Southeast Asia, in March 1966 2d AD was replaced by Seventh Air Force, which reported to MACV for operations in South Vietnam and to Headquarters PACAF for operations in the rest of Southeast Asia in collaboration with Thirteenth Air Force. This command structure remained in effect until the end of the war, with the modification in March 1973 of MACV transforming into the U.S. Support Activities Group and transferring to Nakhon Phanom Royal Thai Air Base, Thailand, along with its air component, Seventh Air Force. Seventh Air Force was deactivated in June 1975. Command relationships were complex throughout the Vietnam War, and the USAF and PACAF continuously sought a centralized control system for all airpower, but the Navy and Marines maintained considerable independence under the direction of PACOM. Even within the USAF, efforts were not centralized, as the Strategic Air Command (SAC) maintained control of its resources operating in Southeast Asia.

In the post–Cold War period, the USAF modified the PACAF structure. The JCS assigned the Alaskan area to PACOM in 1990, and PACAF assumed responsibility for USAF units in Alaska by taking command of Eleventh Air Force, formerly the Alaskan Air Command. In 1991, Thirteenth Air Force left Clark Air Force Base in the Philippines and moved to Anderson AFB on Guam as PACAF assumed responsibility for that base from SAC. The other subordinate numbered air forces in PACAF were Fifth Air Force in Japan and Seventh Air Force in Korea (reestablished in September 1986). PACAF units deployed to Southwest Asia and fought under U.S. Central Command direction during Operation DESERT STORM. Under the USAF expeditionary aerospace force concept in the late 1990s, PACAF provided units on rotation to participate in U.S. Central Command and U.S. European Command security and peacekeeping operations in Southwest Asia and the Balkans.

Jerome V. Martin

See also

Far East Air Forces; Vietnam War

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Pakistan Air Force

The Dominion of Pakistan initiated its constitution on July 1947 after the partitioning of India. The Pakistan Air Force (PAF) began on 15 August 1947, taking more than 50 aircraft transferred from the Indian Air Force as a part of the partitioning. Among these aircraft were British Austers, Harvards, Tempests, and Tiger Moths and Douglas Dakotas, most in need of major maintenance. With these aircraft came 44 pilots, 2,000 airmen, and 200 British-trained officers. Some sources suggest that initially the PAF's officers were British RAF officers. Certainly PAF's structure resembled the RAF in the organization of its squadrons and training facilities. Shortly after the establishment, a training facility was created at Risalpur along the lines of Britain's military training ground at Cranwell. Pilots trained on British de Havilland Tiger Moths and North American Harvards from the United States. Pilots and ground crews trained at Risalpur, Australia, Germany, the United States, and Britain.

Currently, the PAF utilizes aircraft from around the world—fighters, transports, trainers, and reconnaissance aircraft, with an emphasis on interceptor/ground attack aircraft. The PAF maintains 30 air bases across Pakistan. The PAF maintains at least two pilots to every aircraft, though often it is much more. These well-trained pilots maintain their skills by fighting with their Arab allies in conflicts in the Middle East. Pakistan flies aircraft built in the United States, France, and China, with principal reliance placed on the Lockheed Martin (formerly General Dynamics) F-16 Fighting Falcon.

Wendy Coble

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Palau, Battle of (1944)

Air operations in preparation for and support of U.S. Marine amphibious invasion during World War II. The Palau Islands served as stepping-stones toward the Philippines. A general Allied air offensive throughout the area during the summer of 1944 cleared away most Japanese air opposition in the Palaus, Moluccas, and northwestern New Guinea. Ten escort carriers provided close support of the U.S. Marine and Army landings on 15 September. In spite of total dominance in the air, close support was largely ineffective in the ensuing battles because of the rugged nature of the key island of Peleliu and questionable techniques used by carrier pilots trained primarily in the attack of naval targets. As a result, casualties to the ground troops were high, with the 10,000 Japanese defenders exacting a cost 7,000 U.S. casualties before being overcome. Capture of the islands provided bases for the upcoming Allied landings on Leyte and a key fleet anchorage at Ulithi. The battle shows the limitations of air attacks in poor terrain and the importance of specific training relevant to the mission at hand—in this case, low-level attack.

Frank E. Watson

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Craven, Wesley F., and James L. Cate, eds. *The Army Air Forces in World War II, Volume 5: Pacific: Matterhorn to Nagasaki, June 1944–August 1945.* Chicago: University of Chicago Press, 1953.

Palomares Nuclear Incident

Incident involving the destruction of four U.S. thermonuclear bombs as a result of a collision between a Strategic Air Command bomber and a tanker near the Mediterranean coast of Spain.

Late in the morning of 17 January 1966, a SAC B-52G Stratofortress and a KC-135 tanker collided during the course of a normal refueling operation. The bomber was on a routine strategic airborne alert as a part of Operation CHROME DOME and was carrying four Mk.28 (B28) free-fall parachute retarded thermonuclear bombs. The collision took place at 30,500 feet just offshore of Palomares on Spain's southeastern coast. The KC-135's load of jet fuel exploded, destroying both aircraft. All four of the tanker's crew were killed, as were three crewmembers aboard the B-52. Four of the bomber's crew parachuted to safety.

Three of the nuclear weapons fell with the wreckage and impacted the ground near Palomares. One Mk.28 was damaged but remained intact. The high-explosive components of the other two weapons partially detonated, resulting in the destruction of their nuclear components. No nuclear fission occurred in either case, and thus there was no nuclear yield to the accident. The nuclear components were partially pulverized, however, which led to the dispersion of a quantity of finely divided radioactive material beyond the accident perimeter.

The fourth weapon fell into the sea and was not immediately located. Trajectory analysis from Sandia Corporation and the eyewitness account of a Spanish fisherman narrowed the search zone, and a month after the accident three Navy submersibles began exploring the area. The weapon was finally located some 5 miles offshore by the crew of the Navy research vehicle *Alvin.* The bomb casing was damaged but intact, and there was no spread of contamination in the seabed. It was recovered successfully on 7 April.

The cleanup and decontamination operation on the land involved hundreds of U.S. personnel, assisted by Spanish personnel and the Guardia Civil. A large tent city, dubbed "Camp Wilson," was raised near the beach. Large numbers of journalists and visitors attracted by the publicity complicated the operation and made it difficult to control the spread of possible contamination. Eventually, some 1,400 tons of topsoil and vegetation were excavated and removed to the United States for disposal.

Although the accident did not result in a nuclear explosion, it was classified as a Broken Arrow (the USAF code name for an accident involving loss of or damage to a nuclear weapon) because of the nonnuclear detonation of the two weapons and the consequent spread of radioactive material.

Raymond L. Puffer

See also
Strategic Air Command

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Panama Invasion (1989)

Operation JUST CAUSE; massive invasion of the Republic of Panama by U.S. forces to remove a corrupt military regime and protect the lives of U.S. citizens living there. General Manuel Noriega had been the virtual dictator of Panama since the death of General Omar Torrijos in 1981. In May 1989, Noriega, who had been indicted by the United States on drug-trafficking charges in 1988, nullified an election when unofficial counts indicated a clear victory by the opposition slate headed by Guillermo Endara. Noriega survived an aborted coup attempt on 3 October 1989.

U.S. General Maxwell R. Thurman, commander in chief of U.S. Southern Command, placed the command at a heightened state of readiness and updated contingency plans for combat operations in Panama. On 15 December 1989, the Panamanian National Assembly declared Noriega "maximum leader of national liberation." He subsequently declared that Panama was in a state of war with the United States. On 16 December 1989, USMC Lieutenant Robert Paz was killed at a Panama Defense Force roadblock. Shortly thereafter, a U.S. Navy officer and his wife were arrested, interrogated, and roughed up by the Panama Defense Forces.

These two incidents were the catalysts that caused President George Bush to order Noriega's apprehension and the neutralization of the Panama Defense Forces. Under Thurman's direction, Lieutenant General Carl Steiner, commanding general of XVIII Airborne Corps, formed and led a task force of 26,000 U.S. troops in a complex joint operation to do just that. Launched in the early-morning hours of 20 December 1989, the operation involved airborne and air assault troops airlifted from the United States linking up in the hours of darkness with on-the-ground mechanized, light infantry, and special operations units. More than 3,000 soldiers, including Army Rangers, parachuted in—the largest airborne operation since World War II.

The Air Force contingent numbered nearly 3,400, mostly units from the 830th Air Division. The operation included the first action undertaken by the F-117 stealth fighter.

The operation was a resounding success. Twenty-three targets were seized almost simultaneously, virtually decapitating the Panama Defense Forces. Guillermo Endara was installed as the duly elected president of Panama. Noriega sought refuge in the Vatican Embassy but gave himself up on 3 January 1990 to U.S. authorities, who escorted him to the United States to stand trial on drug charges. U.S. casualties in Operation JUST CAUSE included 23 killed and 324 injured.

James H. Willbanks

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Panavia Tornado

Originally known as the Multi-Role Combat Aircraft; an excellent example of international cooperation. The primary

The SEPECAT Jaguar is the joint product of British Aerospace and Breguet Aviation (now part of Dassault) and, with the Panavia Tornado, greatly advanced international cooperation in warplane production. (Kev Darling)

Flown about five years later than the Jaguar, the Panavia Tornado featured cooperation among the United Kingdom, Italy, and Germany. (Kev Darling) constituent partners are the United Kingdom, Italy, and Germany, each being responsible for the manufacture of certain parts of the airframe, engines, and avionics.

The birth of the Tornado can be traced to the turmoil within various European governments that concerned the next generation of combat aircraft. After nearly three years of individual development, the three participating governments finally signed the order to proceed for Panavia on 15 March 1973. A total of 809 aircraft were initially ordered, although this has fluctuated (the Tornado F.3, built for the RAF, was a long-range fighter).

On 14 August 1974, the first prototype made its maiden flight. This was to be the start of a very long development program that saw the airframe undergoing some changes.

The first Tornado deployed was the GR.1 and entered service at Cottesmore for the training of aircrews for all three nations. Throughout its life, the Tornado has undergone numerous upgrades. Some have been reworked to carry out reconnaissance using infrared linescan equipment; the majority of the fleet is being rebuilt to the GR.4 standard. The deployment of the Tornado to the Bundesluftwaffe, Marineflieger, and Aeronautica Militar Italiano began in February 1984 (to Germany; Italy began to operate the Tornado from August 1982).

Overseas sales of the Tornado have been limited to Saudi Arabia, which purchased a mixed package of GR and F.3 aircraft. Abortive attempts to sell the aircraft to Oman and Malaysia eventually failed due to economic reasons.

The RAF used the fighter version. The definitive version became the mainstay of the RAF's defensive effort and is 80 percent compatible with the attack variant. Italy now leases Tornado aircraft from the RAF.

Kev Darling

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Panay, USS

During the warlord years following the Chinese Revolution of 1911, Western powers assigned gunboats to patrol the Yangtze River to protect the lives and property of their nationals from bandit gangs and guerrilla forces. The USS *Panay* (PR-5) was one of five shallow-draft gunboats in China and was commissioned on 10 September 1928. Displacing 450 tons and capable of 15 knots, the ship had a company of 65 men and carried two 3-inch guns and 10 .30-caliber antiaircraft machine guns.

After war erupted between Japan and China on 7 July 1937, Japanese forces attacked Nanking in November, causing the U.S. ambassador, Nelson T. Johnson, to leave on 22 November; on 11 December the remaining U.S. officials and a number of civilians boarded the *Panay* to sail upriver, escorting three Standard Oil of New York (SOCONY) ships. Two British gunboats and several British craft joined this flotilla, which was peppered by Japanese shore batteries.

At 9:40 A.M. on Sunday, 12 December, the *Panay* was stopped by Japanese soldiers. Lieutenant Commander James J. Hughes, the captain of the *Panay,* allowed an armed Japanese party to board in violation of naval procedure. Hughes explained that he was heading upriver "to keep clear of artillery fire" and answered some routine questions but refused to allow a search of the ship; the Japanese disembarked, allowing the *Panay* to continue.

At 11:00 A.M., the *Panay* and the SOCONY ships anchored near Ho-sien, about 28 miles upstream of Nanking. *Panay* displayed a large American flag at the gaff and had 18- by 14-foot American flags painted on the awnings and topdecks; all were illuminated at night. Shortly after the noon meal, Japanese aircraft approached the ship at high altitude and descended to release bombs. This first attack scored a direct hit that wrecked the bridge and one 3-inch gun and seriously wounded Captain Hughes, his executive officer, and several others.

Several attacks, from as low as a few hundred feet altitude, crippled the ship. The crew responded with .30-caliber Lewis machine guns but the ship lost all power and propulsion. Captain Hughes reported that another storm of bombs fell both on the *Panay* and the SOCONY ships.

As the *Panay* began to sink, Hughes ordered the crew to abandon ship. All personnel made their way to a reed bank along the shore where they hid while Japanese aircraft continued to strafe the ship and the boats. The bombing ceased at 2:25 P.M.; a Japanese motorboat approached and machine-gunned the ship, then briefly put men on board to search it. At 3:54 P.M. the *Panay* sank bow first, its colors still flying. In the attack, two sailors and one civilian passenger died and 11 officers and men were seriously wounded. Chinese civilians assisted the survivors to rendezvous with the USS *Oahu* and the HMS *Ladybird* two days later.

Commander Masatake Okumiya declared that the fliers were not informed of the gunboat's presence in the area but were told the mission was to bomb Chinese troops escaping upriver. Japan declared the attack a "regrettable accident" resulting from miscommunication and young, inexperienced pilots that failed to clearly identify the ships.

A U.S. Naval Court of Inquiry held at Shanghai concluded that the sinking was deliberate. Washington, in the throes of isolationism and unprepared for a military conflict, accepted the Japanese explanation, an apology, and indemnity. The *Panay* was the first United States Navy ship to be sunk by hostile aerial bombardment and was a portentous event.

Richard C. DeAngelis with D. Y. Louie

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Pantelleria

Italian island; site of Allied air operations during World War II. As the Allies pressed their way across North Africa, they also began bombing distant targets across the Mediterranean Sea in preparation for the invasion of Southern Europe. Of interest was the Italian island of Pantelleria, located 62 miles southwest of Sicily and some 100 miles east-southeast of Tunis, with a population of some 11,500 people. The island was in the shipping lanes between Tunisia and the larger island of Sicily.

Beginning on 8 May 1943, fighters and light bombers of the North African Tactical Air Forces initiated attacks on landing grounds on the small island. Subsequently, B-17s and B-24s bombed the island. Up until 3 July 1943, 40 air strikes were made against the island. These attacks battered Italian emplacements and demoralized the troops. When a surface assault was made on Pantelleria on 11 June 1943, the Allied forces marched ashore unopposed and were met with white flag–waving enemy forces. This marked the first time in history a complete surrender resulted solely from air attack without ground action. With the capture of Pantelleria and two neighboring islands, Lampedusa and Linosa, Allied seapower had complete control of the sealanes to Italy and Sicily. This marked the first Allied occupation of Italian territory during the war.

Alwyn T. Lloyd

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Pape, Robert A. (1960–)

Influential airpower theorist. Robert Anthony Pape was born in Erie, Pennsylvania, on 24 April 1960. He graduated from the University of Pittsburgh with two degrees in 1982; he received a doctorate from the University of Chicago in 1988. He taught conventional airpower strategy for the United States Air Force at the School of Advanced Airpower Studies, Maxwell AFB, Alabama from 1991 to 1994, and taught international relations in the Government Department at Dartmouth College from 1994 to 1999. In July 1999, he became associate professor of political science at the University of Chicago.

His 1996 book *Bombing to Win: Air Power and Coercion in War* offers a new theory of coercive airpower and tests it in all the major cases of strategic bombing from 1914 to 1991, including the use of airpower against Germany, Japan, Korea, Vietnam, and Iraq. He argued that strategic bombing has not worked in the past and that the strategic air campaign in Operation DESERT STORM was the least effective application of airpower.

His analysis of airpower theory, based on social-science research on the history of international disputes, has greatly influenced both civilian and military audiences.

John Andreas Olsen

See also

DESERT STORM; Warden, John A. III

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Parachutes

Pilot safety device developed from ballooning. The concept of the parachute dates back to at least the seventeenth century, but it wasn't until 1797 that the first successful human jump was made. On 22 October of that year, Frenchman Andre Garnerin jumped from a balloon at an altitude of 2,000 feet; over the next few years, he made additional jumps in France and England. In 1808, the first emergency parachute jump was made when Polish balloonist Jordaki Kuparento was forced to exit the balloon he was piloting after it burst into flames. Kuparento was the first person to save his life with a parachute.

Experimentation with parachutes continued throughout the nineteenth and early twentieth centuries, and by the time World War I began, a successful jump from a powered aircraft had already been made. In addition, new technical advancements had been perfected, including the development of the apex hole to reduce oscillation, the pilot chute to aid in main chute deployment, and the static line for parachute activation.

World War I served to speed up the evolution of the art of parachuting—at least from lighter-than-air craft. The highly flammable hydrogen-filled observation balloons used on the Western Front during World War I made it necessary for observers to carry parachutes aloft. When attacked, observers wasted little time in exiting the wicker basket by way of parachute.

The use of parachutes in powered aircraft in World War I was limited, with few exceptions, to the Germans. Despite the fact that technical problems were unresolved, many German airmen, including second-ranking ace Ernst Udet, saved their lives by leaping to safety from their damaged aircraft.

Between the wars, parachutes became more and more practical, to the point of becoming standard safety equipment in military aircraft. Parachutes subsequently became so successful that an exclusive club, composed of airmen who had managed to save their lives by jumping from a stricken aircraft, was formed. The so-called Caterpillar Club—named in honor of the silkworm, which secreted the substance that early parachutes were made of—numbered 210 members by 1930. By 1955, the club's ranks had grown to over 40,000.

Other uses for the parachute were also developed during this period. During the barnstorming days of the 1920s and in the years afterward, parachuting developed into a popular form of entertainment for both jumpers and spectators. Parachutes were also used for dropping emergency supplies and for delivering smokejumpers quickly and accurately (smokejumpers are courageous firefighters who descend to fight forest fires from the air). In addition, with another world war looming, parachutes began to be used for tactical military purposes. Airborne assault units were deployed in one form or fashion by all the major powers during World War II.

Today, the use of parachutes is commonplace, and they perform many essential functions in the modern world. Skydiving is now a popular sport worldwide. Also, dragchutes are used to help slow high-performance aircraft after they have landed, and spacecraft routinely use parachutes while reentering the earth's atmosphere. Today, parachutes are as much a part of aviation safety as virtually any other device.

Steven A. Ruffin

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Paris Air Agreement

The 1926 agreement that opened the door to German rearmament following the World War I Armistice. From 1919, when Germany signed the Versailles Treaty, its air force was officially banned, forcing the country to use different methods to maintain knowledge and develop new air operational plans. The Paris Air Agreement, signed on 1 September 1926, did not change the ban on an air force, but it dissolved the Allied Aviation Guarantee Committee, which had overseen the enforcement of the treaty on German territory. The agreement also returned complete control of civil aviation to Germany, allowing it to expand commercial airlines and build transport dirigibles. In exchange, the German government agreed to stop funding gliding, which had been introduced as a means to train young pilots. However, in so doing, it shifted the assets of the Sports Flying Group and divided them among the Commercial Pilot Training School (DVS), the Academic Flying Group (Akaflieg—active among university students), and the Aviation Group, a generic name that served as a cover for military air activities on German soil.

The implications of the Paris Air Agreement for plans laid before 1926 by the Truppenamt—the code name under which the German army operated—made several operations easier, such as recruiting replacement fliers for the army's elite 180 pilots, almost half of whom were retiring or unable to fly by the mid-1920s. The new recruits were selected through a program implemented by the German Ministry of Transportation and then trained at schools near Berlin and Braunschweig. The program was classified secret, as was the fact that under German-Russian Treaty of Rapallo, a German base at Lipetsk, Russia, was set up to train fliers. There instructors, recruited from Lufthansa and the DVS, trained pilots. In addition, Lipetsk came to serve as a testing ground for German aircraft, such as the Heinkel 46, Junkers K 47, and Dornier Do 11. Such activities were reduced when the Great Depression hit Germany but did not stop until Adolf Hitler became chancellor in 1933.

In Germany, the Paris Air Agreement also allowed more leeway in how the army camouflaged its industrial activities. Contracts for the development of prototypes were run through dummy corporations, and the operation of several civilian aircraft types had to incorporate instructions concerning wing stresspoints in a way that would allow them to affix bombs and incorporate guns. So as not to anger civilian officials, the phrases used in correspondence stressed that all such aircraft (including Lufthansa machines), were for "defensive use"; nowhere did the word "bomber" appear. Manufacturers went along with the instructions, but the limited orders for each machine type frustrated industrialists involved in these projects. A greater concern was the development of new engines, hampered by the limits of the Versailles Treaty (the Benz aircraft-engine factory was in the Rhineland demilitarized zone, which was under French control until 1930), as well as limited funding.

The result was that by 1932 the German army had more than 200 aircraft ready for combat, including a majority of civilian planes. One study even projected the need for a new air force that would have close to 1,000 aircraft, many of them bombers. However, the poor economy and the fact that most aircraft manufacturers did not have the means to produce so many machines meant that the army would have to wait for improved economic conditions as well as a shift in budget priorities.

Overall, then, the Paris Air Agreement allowed for further maturation of the German army's air planning, from training to testing, operations, and projections. When Hitler came to power, his future chief of the Luftwaffe, Hermann Goering, took advantage of the prepared plans and made them the Third Reich's own, including the so-called 1,000-aircraft program of 1933.

Guillaume de Syon

See also

German Air Force (Luftwaffe); Versailles Treaty

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Park, Keith Rodney (1892–1975)

Royal Air Force air chief marshal. Born in Thames, New Zealand, Park served in the artillery in Egypt and on Gallipoli, where he was commissioned in 1915, and then on the Western Front until wounded and hospitalized in England. Transferring to the Royal Flying Corps in December 1916, he received his wings and briefly instructed before joining No. 48 Squadron in France flying Bristol Fighters. Rising to command No. 48 Squadron by the Armistice, he had been shot down twice, was credited with five victories plus 14 aircraft driven down out of control, and was awarded the Military Cross and Bar plus the Croix de Guerre.

Postwar, Park held a number of successively senior positions in the RAF. By 1938, he was senior air staff officer to Air Chief Marshal Sir Hugh Dowding at Fighter Command, perfecting RAF plans for the defense of Britain. In April 1940, he was promoted air vice marshal, commanding No. 11 Group with responsibility for the fighter defense of London and southeastern England. From July to September 1940, his group provided the principal front-line fighter opposition to the Luftwaffe during the Dunkirk evacuation and the Battle of Britain.

Replaced somewhat controversially in December 1940, Park next commanded a training group, where he was instrumental in the creation of the Air Sea Rescue organization. Appointments as air officer commanding (AOC) Egypt and then Malta followed. Promoted to Air Marshal, he was AOC in chief to Egypt during 1944 and then air commander in chief, South-East Asia Command, during 1945–1946. He was confirmed as air chief marshal in 1946.

Postretirement, he worked for Hawker-Siddeley, returning to New Zealand as the Pacific representative of the Hawker-Siddeley Group. He died in Auckland on 6 February 1975.

Christopher J. Terry

See also

Britain, Battle of; Dowding, Hugh C.T.; Dunkirk; German Air Force (Luftwaffe); Leigh-Mallory, Trafford; Malta, Siege of; Mediterranean Theater of Operations; Radar; Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Patrick, Mason Mathews (1863–1942)

U.S. Army major general. Mason Mathews Patrick was born in Lewisburg, West Virginia, on 13 December 1863. In June 1886, he graduated second in his class from the U.S. Military Academy at West Point. One of his classmates and friends was later General of the Army John J. "Black Jack" Pershing.

Patrick had a wide-ranging career as an engineer, and in 1901 Patrick became the assistant to the chief of the Air Service when the United States entered World War I in April 1917. The U.S. commander, General Pershing, assigned Patrick to the first U.S. contingents to go to France. In September, he was named chief engineer of lines of communication and director of construction and forestry for the American Expeditionary Forces.

The various U.S. aviation units in Europe were uncoordinated and often in competition over resources and missions. Pershing also had two headstrong aviation officers, Brigadier Generals William B. "Billy" Mitchell and Benjamin D. "Benny" Foulois, who separately led operational and supply/administrative aspects of Army aviation. Their rivalry over the use and structure of the Air Service led Pershing, in

May 1918, to place Patrick over all Air Service units and promote him to temporary major general.

After the war, Patrick returned home as an engineering officer. In 1921, Pershing became the Army Chief of Staff. On 5 October, he appointed Patrick chief of the newly reformed Army Air Service. Promoted to permanent major general, Patrick declared that "airmen should be led by an airman!" In 1923, at the age of 60, he had Major (later Major General) Herbert A. Dargue teach him to fly.

Patrick was a visionary who privately agreed with Mitchell that airpower would eventually become an essential part of national defense. However, Patrick believed in gathering overwhelming evidence that proved military aviation's potential and just how far behind U.S. aviation was at the time.

Even though Patrick tried to channel Mitchell's passion for airpower and sent him on long "inspection" tours of European and Pacific installations, he could not keep him out of trouble with Army and civilian leadership. By the fall of 1925, Mitchell, while right in most ways, had clearly been insubordinate. Between 28 October and 17 December 1925, Patrick sat through Mitchell's bitter court-martial and predictable conviction. He was left to save the Air Service's reputation, which he did.

Patrick seized opportunities to garner positive publicity for the Air Service. Under Patrick's steady leadership, Army airmen set many aviation records. He also facilitated the creation of flight laboratories and experimental flying facilities at Wright Field, all of which became part of the Materiel Division (1927–1942) and today's Air Force Materiel Command.

In 1926, Patrick played a key role in the formulation and passage of legislation that created the Army Air Corps—a major step toward organizational independence. The Air Corps's formation led to the creation of the position of assistant secretary of war for air, a powerful new subcabinet post.

Patrick retired on 12 December 1927, living the remaining years of life as a revered aviation expert and grand old man of the air force. He died at Walter Reed Hospital on 29 January 1942, at age 78, and was buried at Arlington National Cemetery. On 26 August 1950, the Air Force's long-range proving ground near Cocoa Beach, Florida, was named Patrick AFB in his honor.

William Head

See also

Dargue, Herbert A.; Foulois, Benjamin D.; Mitchell, William

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Patterson, Robert Porter (1891–1952)

Post–World War II secretary of war; instrumental in desegregating the Army and creating the Department of Defense. Born in Glens Falls, New York, on 12 February 1891, Patterson was educated at Union College and Harvard Law School, where he was president of the *Harvard Law Review.* He practiced law in New York City from 1915. In World War I, he earned two citations for gallant and meritorious service "in utter disregard of personal danger." He was awarded the Distinguished Service Cross and won a Purple Heart for wounds received in an action on 16 August 1918. He returned to the United States in April 1919, mustered out of the Army as a major, and resumed his law practice in New York.

In 1940, he became assistant secretary of war. Then he became the first undersecretary of war. In that position, he was responsible for procurement of more than $100 billion worth of supplies and equipment, the largest amount of business ever carried out by one organization to that time. He was also largely responsible for the desegregation of the Army.

After World War II ended, he served as secretary of war. As the Cold War set in, Patterson advised President Harry S. Truman on China, Greece, Turkey, and other troublespots in the lead-up to the Truman Doctrine. Patterson's tenure (1945–1947) was one of rapid demobilization, but it was also a time for rethinking the structure of U.S. military forces. Patterson played an important role in the negotiations, politicking, and maneuvering that eventuated in the unification of the armed forces, the establishment of an independent Air Force, and the creation of the Department of Defense. He elected to return to private business rather than become the first secretary of defense.

He died in a commercial airliner crash on 22 January 1952 and was buried in Section 30 of Arlington National Cemetery. His wife, Margaret T. Winchester Patterson, died on 28 May 1988 and rests beside him.

John Barnhill

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Pattle, Marmaduke Thomas St. John (1914–1941)

South Africa's ace of aces; perhaps the best fighter pilot in the Royal Air Force/Commonwealth Air Forces during World War II. He was a squadron leader in the RAF, with 34-plus victories in the Middle East and Greece. He was awarded the Distinguished Flying Cross and Bar.

Pattle was born on 23 July 1914 in Butterworth, Cape Province, South Africa. In 1936, he became a cadet in the Special Service Battalion. When Pattle was assigned to No. 80 Squadron, flying Gloster Gladiators, he was evaluated as "exceptional"—a highly skilled marksman and an above-average flier.

When Italy entered World War II in June 1940, the Egypt-based No. 80 Squadron got its first taste of combat. Pattle mostly flew the Gladiator, although the squadron also had a small number of Hurricanes. On 4 August 1940, Pattle's flight of four Gladiators engaged 27 Italian aircraft; he scored two kills. He was shot down over Libya that day but made it back to the British lines after a two-day walk.

November 1940 saw Pattle's No. 80 Squadron transferred to Greece. He scored two Fiat CR.42 kills on his first sortie. Upon taking command of the squadron on 25 November 1940, Pattle was presented with the Distinguished Flying Cross (DFC). On 12 March 1941, he took command of the Hurricane-equipped No. 33 Squadron with promotion to squadron leader. By this point, he had 20 kills and several unconfirmed. Eleven days later her earned the Bar for his DFC by getting one air victory, several unconfirmed, and three ground kills.

On 6 April 1941 the Germans attacked Greece, and Pat Pattle began a regular pattern of German kills, many of which were never recorded due to the desperate Allied situation. Pattle grew very ill around this time, a combination of fatigue and influenza, but continued to fly even after the medical officer grounded him except in the case of air raids.

On 20 April, in grave physical condition, Pattle and the combined No. 80 and No. 33 Squadrons intercepted more than 100 German aircraft. He was killed over Eleusis Bay after saving another Hurricane and shooting down several German fighters.

Some estimates of his enemy kills exceed 60, but many of official records were destroyed, so the actual number is unknown. This man—small in stature but large in courage and ability—was one of South Africa's great air heroes of the conflict.

Scott R. DiMarco

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Pave Nail

Early code name for laser-guided munitions, or smart bombs. In the late 1960s, the U.S. Air Force began using laser-guided bombs in the Vietnam War. A tremendous advancement in aerial delivery of ordnance, they allowed aircraft to destroy precise targets with one or two bombs instead of dozens or even hundreds of unguided dumb bombs.

Laser beams generated by guidance pods carried by aircraft guided the munitions to the targets. The first Pave Nail planes were 15 OV-10 Broncos assigned to the 23d Tactical Air Support Squadron stationed at Nakhon Phanom Air Base in northeastern Thailand. These aircraft were modified in 1971 to carry a Pave Spot guidance pod and a LORAN long-range navigation system. This gave them all-weather precision-guidance capability. The crew consisted of a forward air controller/pilot in the front seat and a forward air navigator who sat in the back seat and operated the Pave Spot system.

Seventh Air Force used this system very effectively in the COMMANDO HUNT operations along the Ho Chi Minh Trail, against the invading North Vietnamese Army in the Easter Offensive of 1972, in the last operations over Cambodia in 1973, and in search-and-rescue operations throughout. Two of the aircraft were downed by enemy ground fire, and one was downed by an SA-2 surface-to-air missile during the rescue operation for Bat 21 Bravo in April 1972. In 1974, the Pave Spot pods were removed and the program was terminated.

Darrel Whitcomb

See also

BAT 21

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Pearl Harbor

Surprise Japanese attack on U.S. Pacific Fleet in the Hawaiian port of Pearl Harbor on 7 December 1941; resulted in the United States entering World War II. The first strike occurred at 7:52 A.M. local time followed by a second strike at 8:55 A.M. that lasted about an hour. Casualties from the attacks included 2,335 dead servicemen, 1,104 of whom perished aboard the USS *Arizona* when a direct hit to the magazine resulted in an explosion that ripped the ship apart; 1,178 wounded; and 68 civilians dead. Capital damage included the destruction of 188 planes and eight battleships. In addition, three light cruisers, three destroyers, and three smaller vessels sustained irreparable damage.

Japanese pilots, under the command of Admiral Nagumo Chuichi, took off from six aircraft carriers located 274 miles

The Japanese-eye view of the attack on Pearl Harbor, showing a torpedo hit on the USS West Virginia. *(U.S. Navy)*

off the coast of Oahu on the morning of 7 December. The first wave of 183 planes—assigned to target specific airfields and "Battleship Row," where the majority of the U.S. Pacific Fleet remained moored—headed for Hawaii at 6:00 A.M. At 7:02 A.M. two Army radar operators stationed at Opana Radar Station detected the approach of the planes, but a junior officer failed to relay the information, believing that the planes were B-17s scheduled to arrive from the West Coast.

At 7:15 A.M. the second wave of fighters headed for Hawaii. By 7:53 A.M. the first group of Japanese planes, which included 51 Val dive-bombers, 40 Kate torpedo-bombers, 50 high-level bombers, and 43 Zero fighters under the command of Mitsuo Fuchida, commenced their attack. The Wheeler, Kaneohe, Ford Island, Hickam, Bellows, and Ewa airfields sustained damage during the first wave of attack. The battleships hit included the *Arizona, Oklahoma, West Virginia, Pennsylvania, Tennessee, Maryland, Nevada,* and *California.* The USS *Lexington, Saratoga,* and *Enterprise,* out of port at the time of attack, remained undamaged and played a role in the destruction of Japanese submarines.

Japanese losses included 27 aircraft and five midget submarines dispatched into the harbor with orders to torpedo any undamaged ships. Following their victory at Pearl Harbor, the Japanese attacked numerous islands throughout the Pacific with impunity for six months before the U.S. Fleet regrouped and started winning major naval battles, eventually turning the tide with the victory at Midway Island, where U.S. forces destroyed four Japanese battleships.

Investigations into defense preparations on the island occurred after the attack. Admiral Husband E. Kimmel and Army Lieutenant General Walter C. Short were relieved of duty for failing to implement appropriate defense measures. Admiral Chester W. Nimitz assumed command of the Pacific Fleet. By attacking the United States, the Japanese created a sense of urgency among officials that extended past the surrender of Germany and Italy.

Cynthia Clark Northrup

See also

Fuchida, Mitsuo; Nagumo, Chuichi; Nimitz, Chester William

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One of the most famous photos of the damage resulting from the Japanese raid on Pearl Harbor, 7 December 1941. (U. S. Navy)

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PEDESTAL (1942)

Code name for convoy operation that suffered heavy losses while bringing desperately needed supplies to British Malta in the central Mediterranean. By August 1942, Malta was short of almost all supplies, and rations had been cut substantially. The British Admiralty planned a massive convoy moving east from Gibraltar to bring in enough supplies to end the danger of Malta being starved into submission. Four aircraft carriers and two battleships escorted 14 merchantmen.

From the beginning, Italian reconnaissance aircraft tracked the convoy. A U-boat sank the carrier *Eagle,* and Axis bombers heavily damaged the carrier *Indomitable.* Two Italian fighters, with silhouettes similar to that of the British Sea Hurricane, entered the carrier *Victorious*'s landing pattern in a daring attack and dropped two 1,000-pound bombs. One hit the bow and scattered fragments over the antiaircraft gun crews, and the other hit the deck and broke up without exploding. Nine of the merchantmen were sunk and three damaged by a combination of U-boats, E-boats, torpedo bombers, and dive-bombers, but the convoy delivered 55,000 tons of supplies.

The supplies enabled Malta to resume offensive operations against Axis supply lines to Africa. By the time another supply convoy was necessary, the Allies had gained the advantage in the Mediterranean and the convoy was only lightly opposed.

Grant Weller

See also
German Air Force (Luftwaffe); Hawker Hurricane; Malta, Siege of; Mediterranean Theater of Operations; Regia Aeronautica (World War II)

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Peenemünde

Site of German special-weapons research and subsequent Allied attacks. As the Allies became aware of German special-weapons development during World War II, and of the important developmental role of the Peenemünde site on the Baltic coast, extensive monitoring of the area by aerial reconnaissance and photography was undertaken. Ultraintelligence contributed to a growing picture of an extensive missile program. CROSSBOW, the overall code name for the Allied response to what became the German V-1 and V-2 programs, determined that the missiles were in advanced testing and that they—as well as key German scientific personnel—had to be destroyed as soon as possible.

On the evening of 17–18 August 1943, three waves of 560 RAF bombers—Halifaxes, Stirlings, and Lancasters—were sent on Operation HYDRA against Peenemünde targets. At the same time, a small force of eight RAF bombers were sent to Berlin to act as decoys to confuse the Luftwaffe's response to the main raid.

Over Peenemünde, Pathfinders led the first wave of 227 bombers to obliterate the site's worker housing estate (18 of 30 huts destroyed), though the specific aim of this wave was the scientific and technical personnel who were housed nearby. The second wave was 113 Lancasters aimed at the V-2 production works located at Peenemünde South. And the third wave of 180 bombers was sent to attack the experimental development works of Peenemünde East and hit 50 of 80 buildings. In all, 1,600 tons of high-explosive and 250 tons of incendiary bombs were dropped in the three waves, which accomplished their attacks on a moonlit night between 1 A.M. and 2 A.M.

The Luftwaffe was successfully decoyed over Berlin and did not attack the Peenemünde force until the third wave, shooting down 40 bombers, or about 7 percent of the RAF aircraft. But while that aspect of the British attack was successful, and more than 730 were killed, Operation HYDRA accomplished only some of its aims. Most of those killed were prisoners and foreign workers, as the bombs were misdirected and thus killed few of the important scientific and technical people. And while the attack delayed V-1 and V-2 implementation for 4–8 weeks, several vital facilities were only partially damaged or not damaged at all. These included the vital control building, liquid oxygen manufacturing site, wind tunnel, and the airfield where V-1 experiments were taking place. The large Test Stand VII used for launching test-model V-2s was only slightly damaged.

Ironically, the attack may have aided the Germans. As basic missile and rocket development work at Peenemünde had been completed, the chief effect of the attack was to alert the Germans to disperse V-1 and V-2 mass production to protected sites underground. Further, as Peenemünde remained under constant monitoring, the Germans left much of the damage in place to persuade the Allies that all work had stopped.

After V-1s began to drop on Britain, a later U.S. Army Air Forces daylight precision raid by more than 375 B-17s on 18 July 1944 was followed up with missions on 4 and 25 August 1944. All told, more than 800 bombers dropped 1,900 tons of bombs on the three raids. By the time the Russians occupied the site in May 1945, Peenemünde was but a shadow of its developmental days with only a skeleton garrison.

Christopher H. Sterling

See also
German Rocket Development; Ultra; V-1 Missile and V-2 Rocket

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Peltz, Dietrich (1914–)

German major general; one of the most controversial commanders in the Luftwaffe. Peltz joined the German Army in 1934, transferred to the Luftwaffe in 1935, and was in command of a *staffel* (squadron) of Ju 87 dive-bombers during the Polish and French campaigns. He transferred to Ju 88 medium bombers during the Battle of Britain and won the Knight's Cross of the Iron Cross for his bravery and skill. After leading bomber units on all fronts, he was promoted to colonel and named general of the bomber arm, a staff position within the Luftwaffe High Command, but returned to combat duty in March 1943 as *Angriffsfuehrer* England (Attack Leader England). The bombing campaign he led, called the "Baby Blitz" by the English, was ordered by Hitler in revenge for Allied air attacks on Germany. It was finally called off in early 1944 owing to its ineffectiveness and high German losses, but Peltz was held blameless; he was awarded the Oak Leaves with Swords to the Knight's Cross of the Iron Cross and promoted at age 29 to brigadier general.

Peltz's career took a startling turn in October 1944, when he was named commander of II Jagdkorps (Fighter Corps), which contained all of the fighters on the Western Front. Peltz had no experience in fighters, and morale among the fighter-unit commanders plummeted. German fighter losses over the Ardennes were extremely high, and on 1 January 1945 Operation BASEPLATE (*UNTERNEHMEN BODENPLATTE*), which Peltz had planned, cost the Luftwaffe 214 fighter pilots, including 19 formation leaders, and destroyed the fighter force beyond any hope of rebuilding.

Peltz was next given command of IX Fliegerkorps (Jagd) (Air Corps [Fighters]), which contained all of the Luftwaffe's Me 262 fighters and, in March 1945, was promoted to command the Reichsluftverteidigung (Air Defense of Germany), the position he held at war's end. Postwar, his management skills were in great demand, and he had a very successful career in German industry.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Pepelyaev, Evgenii Georgievich (1918–)

Soviet fighter ace during the Korean War. Evgenii Georgievich Pepelyaev was born on 18 March 1918 in Bodaibo, Siberia. He joined the army in 1936 and completed flight school in 1938. He spent World War II in the Far East and flew only 42 combat missions. In 1950, he became commander of the 196 IAP (Fighter Air Regiment), and in April 1951 he led this regiment to Antung, Manchuria, for combat over Korea. When the regiment stood down in February 1952, it had claimed 104 victories for the loss of 25 aircraft and five pilots. Pepelyaev flew 108 missions over Korea and fought 38 air combats. He was officially credited with 20 victories, including 16 F-86s, and gave three more victories to his wingman. He was never shot down. Pepelyaev was awarded the Hero of the Soviet Union on 22 April 1952. He retired in 1973.

George M. Mellinger

See also
Fighter Air Corps; Soviet Air Force

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Pershing, John Joseph (1860–1948)

General of the Army; commanded the American Expeditionary Forces in France during World War I and became the most influential U.S. military officer in the years after the war. Born in Laclede, Missouri, "Black Jack" Pershing graduated from the U.S. Military Academy in 1886. He served in the cavalry on the frontier and in Cuba, but he made his reputation in the Moro Wars (1903–1913). That reputation and his marriage to the daughter of the chairman of the Senate Military Affairs Committee gained his promotion from captain to brigadier general in 1906.

Pershing's first extensive exposure to aircraft came in 1916. He commanded the Punitive Expedition dispatched by the Woodrow Wilson administration to pursue the Mexican revolutionary and bandit Pancho Villa, who had raided into the United States. The Signal Corps's 1st Aero Squadron, commanded by Captain Benjamin D. Foulois, accompanied the expedition, composed largely of horse cavalry units. Pershing anticipated that Foulois's aircraft would provide reconnaissance, flank protection, and communications between his dispersed mounted columns. Initially, the 1st Aero Squadron was able to fulfill these expectations, but the aircraft soon broke down due to a combination of mountainous terrain, desert climate, and continuous operations, forcing the unit to withdraw to the United States for refitting. The trucks and automobiles of the squadron's ground section proved more valuable than the aircraft. They provided the nucleus of the motorized supply line that Pershing improvised when President Venustiano Carranza denied the Punitive Expedition access to the Mexican national railways.

Although Pershing was disappointed, this unpromising beginning did not prejudice him against military aviation. When assigned to command the American Expeditionary Forces in 1917, Pershing made aviation in France completely independent of the Signal Corps. Generally, Pershing followed the advice of experts in this as well as other technical areas. During operations he gave his aviation commanders considerable freedom to innovate, in contrast to the control he exercised over his corps commanders.

When a destructive feud developed between Foulois, now a brigadier general, and Colonel William Mitchell, Pershing assigned Foulois to the support base, gave Mitchell an operational command, and brought in his West Point classmate, Brigadier General Mason M. Patrick, to head aviation in the American Expeditionary Forces.

In the postwar congressional hearings on reorganizing the War Department, Pershing took a progressive stance on aviation's role in the Army (in contrast to his position on armor). He called for a separate department of aviation that would fund research and development, procurement of equipment, and personnel but would assign military and naval aircraft (and their pilots and ground crews) to the control of the War and Navy Departments. When Congress did not adopt these recommendations, Pershing supported the creation of the Army Air Service. Although he continued to recognize the need for further development of the aerial arm, he was not willing to advocate it at the expense of the other arms and services of the Army.

Secretary of War John W. Weeks blocked Pershing's attempt to present his concerns about lack of funds in the Army's budget directly to President Warren G. Harding. Pershing, although he disagreed with this decision, accepted it as a legitimate exercise of civilian control.

Although Pershing agreed with Mitchell, now a brigadier general, that something was wrong with the postwar Air Service, he regarded Mitchell's methods of appealing directly to the public as too "Bolshevik."

Pershing, because of his command of the American Expeditionary Forces, came to symbolize the Army in the 1920s. As Chief of Staff he was also head of the General Staff. Mitchell and his followers attacked the General Staff as wrongheaded and reactionary in its supervision of military aviation, the cause of all the Air Service's problems. The General Staff, however, was simply enforcing the programs of the Harding and Calvin Coolidge administrations.

But Mitchell could not attack the president of the United States by name: To do so would have been an attack on the principle of civilian control. Pershing saw military aviation as an important adjunct of the ground forces. In his view, aviation could not act independently and decisively in war. Thus, there were real differences between Pershing and Mitchell on aviation policy. Pershing was much more concerned with what aircraft could do in the present and the immediate future while Mitchell was more focused on their long-term potential.

Edgar F. Raines Jr.

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Peru-Ecuador Boundary Conflict

A series of local wars during the twentieth century. The independence of Latin America, with the division of the Spanish regions into many republics, left a legacy of disputed boundaries, particularly between Ecuador and Peru. Airpower became a factor during local boundary wars.

Peru, the larger and somewhat more stable nation, achieved important aviation progress during the 1920s. Important connections with U.S. aircraft manufacturers developed. Much less aviation effort was undertaken in Ecuador.

Peruvian officers had observed U.S. Marine Corps aviation in Nicaragua (1931). In July 1941, the conclusion of a Peruvian offensive was likened to a blitzkrieg, for their modern North American (NA-50) and Douglas (DB-8A) monoplanes and twin-engine Italian Capronis met no opposition from Ecuador.

World War II led to the true development of an Ecuadorian air force, which became separate from the army in 1944. U.S. Lend-Lease aid was generous to repay use of Ecuadorian bases to protect a flank of the Panama Canal. A military flying school was definitively organized in March 1942; Ecuadorian pilots also trained in Texas. After World War II, the powerful Republic P-47 Thunderbolts required additional preparation in the United States for Ecuadorian pilots.

Both countries continued to modernize their air forces, and conflicts were frequent. In early 1981, Peru attacked Paquisha, an outpost in the disputed region. Unlike 40 years earlier, Ecuadorian airpower was able to patrol the national territory and limit Peruvian effectiveness during the few days of combat. On 28 January 1981, aerial combat between Cessna A-37B ground attack aircraft of both sides produced slight damage. In the aftermath of Paquisha, significant improvements were made by Ecuador. Weapons upgrades for the Dassault Mirage F.1 and the Israeli Kfir C.2, plus a radar system enabling these interceptors to be effectively deployed, evened the airpower balance.

When the dispute again erupted in 1995 (the War of the Condor, or Upper Cenepa War), several Peruvian aircraft were shot down or damaged. Fortunately, the localized war soon ended, and an acceptable boundary agreement was achieved by 1998.

Airpower played an important role in projecting armed force into a remote region. Evolving tactics and equipment proved crucial, even above unexplored mountains and jungle. The boundary dispute helped develop Peruvian and especially Ecuadorian military aviation. These air services are capable today of important logistical and emergency operations, now that peace has come to the defined frontier.

Gary Kuhn

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Petersen, Frank E. (1932–)

Three-star general; the first African American pilot in the U.S. Marines. Born in Topeka, Kansas, Frank Petersen learned electronics in his father's shop. When he joined the Navy in 1950, he attended electronics school after a debate with the recruiter over whether or not he cheated. He qualified for Navy pilot training after Jesse L. Brown, the first black Navy pilot, died in Korea. The Navy had two other black fliers. Petersen opted for the Marines, survived training and racism, and earned his wings, becoming the first African American Marine pilot (between 1950 and 1953, black Marines increased from 2 percent to 6 percent of the Corps).

Not wanting a southern U.S. assignment, Petersen received orders to El Toro, California. He flew in Korea as a Marine Corps Reserve second lieutenant, finishing 64 missions and earning the Distinguished Flying Cross. Promoted to first lieutenant and made regular in 1954, he served in El Toro until 1960, at which time he went to Hawaii, then to Iwakuni, Japan. At Iwakuni, Major Petersen made his first investigation of racial conditions in the Marines.

At Quantico's Amphibious Warfare School in 1964, his staff study was on racism in the Marines. He continued to rise, finishing college and making lieutenant colonel in 1967. In Vietnam he became the first black fighter-squadron commander in the Marines; as commander of the Black Knights he won a Purple Heart, and the squadron was considered the best in the Marines. He continued his controversial investigation of military racism as special assistant to the commandant in the late 1960s and early 1970s.

In the 1970s, he completed studies at the National War College. He was promoted to colonel in 1975 and to brigadier general in 1979. He attained three-star rank in 1986. He retired in 1988 from command at Quantico. Petersen is the first black Marine general and highest-ranking black Marine to date.

John Barnhill

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Petlyakov Aircraft

World War II bomber aircraft designed by V. M. Petlyakov. Vladimir Mikhailovich Petlyakov was born on 27 July 1891 and studied aerodynamics with Nikolai Zhukovsky, the father of Russian aviation. During the 1920s, he became one of the leading deputies of Andrei Tupolev, specializing in wing design. From October 1931, he was chief of the heavy aircraft design brigade, playing a central role in the design of the Maxim Gorky and the TB-3. In July 1937, Petlyakov, like many Soviet designers, was arrested and sent to a design prison (*sharaga*), officially for excessive delay in completing the ANT-42 heavy bomber, designated TB-7 by the air force, and later redesignated Pe-8 in his honor. While in prison he also designed the Pe-2, which became the standard wartime Soviet tactical bomber. After his release in 1940, Petlyakov was appointed director of his own design bureau in Kazan but was killed in a flying accident in January 1942.

The Pe-8, the only heavy bomber used by the Soviets during World War II, had four engines on the wings and a fifth mounted in the fuselage to power a compressor. It was not very successful, and only 91 were built. The Pe-8 conducted a number of raids on Berlin, Königsberg, and Danzig during 1941 but flew few missions during the rest of the war. Its most famous flight, on 19 May 1942, brought Foreign Minister V. M. Molotov and his staff to Britain.

Far more significant was the Pe-2, the standard twin-engine dive-bomber, with 11,467 examples built, including 365 fighter variants. Its speed and maneuverability made it difficult to intercept. After the war, many examples were handed down to Eastern European countries.

George M. Mellinger

See also

Tupolev Aircraft

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Pfalz Aircraft

Bavarian aircraft manufacturer. The Pfalz Flugzeug Werke opened operations in the summer of 1913 with financial help from the government of Bavaria. The political demands of the confederation of kingdoms, principalities, duchies, and free cities that made up the German Empire during World War I required the maintenance of separate military units for the larger ones. Bavaria was the first of the non-Prussian kingdoms to establish its own aviation units, and its government was naturally just as interested in a having a reliable, non-Prussian source of supply as it was in having its own soldiers. The company was managed by the Eversbusch brothers: Alfred, Ernst and Walter. Prior to the war, the brothers obtained a license to produce Morane-Saulnier aircraft.

The Eversbusch brothers (minus Walter, who had been killed testing a company design in 1916) also became known as aggressive marketers, and there are many photographs of them socializing with, or showing off company products to, the leading German pilots of the day. After having contributed a monoplane fighter that bore a strong resemblance to the Fokker Eindecker, Pfalz produced another single-seater, the D.III, in 1917.

The Pfalz D.III, like its Albatros D.III counterpart, had a sesquiplane layout, the lower wing being narrower than the upper. The lines of the Pfalz were much cleaner than the Albatros, however, giving it one of the sleekest appearances of any World War I fighter.

Armament was the conventional arrangement of two LMG.108 (Spandau) machine guns firing through the propeller, the guns being buried under the engine cowling. This proved a maintenance problem, and in the refined D.IIIa they were moved to an exposed position. Slower than the Albatros, the Pfalz did not replace it but did serve as a supplement to it in several *jagdstaffeln* (fighter squadrons).

The last wartime Pfalz design to see significant production was the D.XII. A single-seat fighter with two-bay wings and the same "N" struts that characterized its contemporary, the Fokker D.VII, the Pfalz made its first appearance at the second German fighter trials in June 1918. The trial's winner was the Fokker D.VIII monoplane, but the Pfalz made a sufficient impression that it was ordered into production.

Although it utilized the same engines as the Fokker D.VII (the Mercedes or the BMW) and fit its same general description, the D.XII was not initially as popular as the Fokker, either with the pilots who flew it or the crews who had to maintain its more complex rigging. Reports indicate, however, that once they had grown used to it, pilot opinion changed. Late in 1918, the D.XII served with Jagdgeschwader III, a half-dozen other *jagdstaffeln,* and a few home-defense units.

James Streckfuss

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Philippines (1941, 1944)

Key archipelago in the Pacific Theater; site of U.S. occupation, Japanese conquest, and eventual Allied liberation.

1941 Air Operations

In August 1941, ground forces from the United States Army Forces Far East (USAFFE) were supplemented by air assets (composed of the 4th Composite Group, 19th Bombardment Group, 24th Pursuit Group, 27th Bombardment Group, and the 2d Observation Squadron) already stationed on the islands. These units were redesignated the USAFFE Air Force. In reality, this "air force" consisted of only 210 aircraft, less than half considered modern. The rest of the force consisted of obsolete Boeing P-26A and Seversky P-35A fighters, Martin B-10 and Douglas B-18 bombers, and various reconnaissance and cargo aircraft. Throughout the fall, the 24th Pursuit was strengthened by the arrival of additional Curtiss P-40E fighters and the 19th Bombardment Group by new Boeing B-17C and B-17D bombers, bringing the total number of aircraft to more than 250. The bombers were gathered at the only two fields that could handle them, Clark and Del Monte. The fighters were based at various airfields on Luzon. Patrol Wing 10 made up the USAFFE naval air assets in Manila and consisted of 28 Catalina PBY amphibious planes, one observation plane, four utility planes, and four seaplane tenders. Because the 27th Bombardment Group's planes never arrived, their pilots flew from Luzon to Australia after 7 December.

On 8 December, after Japanese army bombers bombed military installations near Baguio, 108 twin-engine Japanese naval bombers, escorted by 84 Zero fighters, headed for the Clark and Iba airfields. The U.S. forces armed and fueled their bombers for a raid on Japanese airfields on Formosa while fighters from the 3d, 17th, and 21st Pursuit Squadrons were sent aloft to deter any Japanese attacks. For reasons still disputed to this day, the Japanese Eleventh Air Fleet caught the USAFFE Air Force planes at Clark and Iba off-guard, destroying most of them on the ground. P-40s from the 3d returning to Iba managed to drive off strafing Zeros, but the P-35s from nearby Del Carmen were able to shoot down only three Zeros over Clark. The attack left the USAFFE with only 17 B-17s, 54 P-40s, and 49 P-35s intact; the installations at Clark and Iba were heavily damaged. Patrol Wing 10, based at Cavite and Olongapo, was not damaged. The Japanese struck again on 10 December, hitting Cavite and Clark, Del Carmen, Iba, and Nichols airfields. This attack and subsequent ones on 12 and 13 December left the USAFFE with 16 operational bombers, 22 P-40s, about a half-dozen P-35s, and a few P-26s. On 12 December, Patrol Wing 10 lost seven of its PBYs to Zeros that followed them back to Olongapo. Several more PBYs were lost the following day. To keep from losing all their bombers, the 19th's B-17s were moved on 15 December from Del Monte to Darwin, Australia.

Before the B-17s evacuated Luzon, Japanese forces landed at Appari and Gonzaga. In an effort to drive off the landing forces, two B-17s from Clark attacked the transports. Although their attack resulted in little damage to the invasion force, it did provide the USAFFE and America its first World War II hero, Captain Colin P. Kelly, who posthumously earned the Distinguished Service Cross for this action and subsequent saving of his crew when they were attacked by Zeros. USAFFE sent small groups of P-35s, P-40s, and B-17s to disrupt the Japanese landings at Vigan and Legaspi. The attacks resulted in only a few transports sunk at Vigan and a few enemy fighters shot down at Legaspi.

After the destruction of Clark Field and other airbases around Manila, USAFFE was left at the mercy of Japanese bombers. Although some aircraft of the 24th Pursuit were able to keep flying, lack of spare parts and replacements spelled the end of U.S. airpower and the eventual capture of U.S. strongholds at Bataan and Corregidor by the Japanese. Those air units that were still intact, such as the U.S. Navy's Patrol Wing 10, abandoned the Philippines in mid-December and its Dutch East Indies bases of operation in the winter of 1942 for the safer and more secure Australian shoreline near Perth.

1944 Air Operations

The year 1944 saw the return of U.S. forces to the Philippines as Task Force 38, lead by Vice Admiral Marc A. Mitscher, sent carrier aircraft to bomb and strafe Japanese airfields on northern Luzon (11 and 14 October), Formosa (12–14 October), and the area around Manila (15 October), destroying more than 800 enemy aircraft, with more than half shot down by U.S. carrier planes. These attacks achieved their goal of clearing possible reinforcement areas and paved the way for the landing of U.S. Army troops on Leyte on 20 October. Besides carrier-based support from Task Force 38, the escort carriers (CVEs) of Task Force 77.4, lead by Rear Admiral Thomas L. Sprague, added their aircraft to operation on 18–23 October.

The Japanese fleet, intent on stopping the invasion, converged on the islands as a three-pronged force, but carrier aircraft from the U.S. forces attacked the southern and central Japanese forces in the Sulu and Sibuyan Seas. They sank the Japanese battleship *Musashi* and a destroyer, and Japanese air attacks claimed the CVE *Princeton.* The Japanese southern prong was defeated by elements of the U.S. Seventh Fleet in the Surigao Strait, losing two battleships and three destroyers. The central prong was able to gain passage through the San Bernardino Strait and bombarded Task Force 77.4's CVEs and escorts, sinking *Gambier Bay* and a destroyer escort, while carrier aircraft sank three Japanese heavy cruisers. Almost simultaneously, Task Force 38 found the northern prong of the Japanese force off Cape Engano, sinking the Japanese carrier *Zuikaku* and light carriers *Chiyoda, Zuiho,* and *Chitose.* In the Leyte Gulf, Japanese kamikazes made their first appearance, sinking the CVE *St. Lô* and damaging the CVEs *Sangamon, Suwannee, Santee, White Plains, Kalinin Bay,* and *Kitkun Bay.*

As the battered Japanese forces retired homeward on 26–27 October, U.S. carrier aircraft struck a final time, sinking a light cruiser and four destroyers. On the last day of the naval battle, carrier aircraft struck Japanese airfields in the Visayas. The outcome of this battle, which gutted the Imperial Japanese Navy, allowed the U.S. invasion of Leyte to continue unmolested.

In response to these raids, the Japanese launched kamikaze attacks beginning on 29 October and continuing through 25 November. Carriers damaged by these actions included *Intrepid, Franklin, Belleau Wood, Lexington, Essex,* and *Hancock* and the CVE *Cabot.* To blunt U.S. airpower on occupied Leyte, the Japanese also conceived a suicide mission involving paratroop drops on airfields near San Pablo and Buri. Although the paratroops succeeded in taking the airfield at San Pablo, it was a short-lived victory, and overwhelming U.S. forces eventually retook the field. U.S. forces undertook amphibious, airborne, and glider operations to secure Luzon and, by April 1945, had isolated the three Japanese armies, occupying the Philippine archipelago.

Brian B. Carpenter

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Piaggio Aircraft

Italian aircraft and engine manufacturer. Founded in 1884 as a sawmill by Rinaldo Piaggio (1864–1938), it soon extended its activity to naval furnishings and rolling stock. In World War I, Piaggio repaired seaplanes and manufactured spare parts. It joined the great Caproni Ca.5 program but only produced a few floatplane conversions.

Acting in a personal capacity, Senator Piaggio in 1921 helped found CMASA, which built Dornier Wal seaplanes in circumvention of the Versailles Treaty; a number were eventually assembled by Piaggio and used by SANA, an airline created in 1924 with Piaggio participation. In 1923, Piaggio took over the Pegna-Bonmartini firm, hiring its chief designer, Giovanni Pegna (1888–1961). A number of advanced prototypes were built to Pegna designs, including the PC.7 hydrofoil seaplane racer (1927), but the factory subsisted largely on license production of SIAI Marchetti seaplanes, including an all-metal S.55 variant designed by Giuseppe Gabrielli (1903–1987), who in 1931 left for Fiat. In 1930, Piaggio started building variable-pitch propellers from the patents of Corradino D'Ascanio (1891–1981), who also designed the PD.2 and PD.3 experimental helicopters.

Piaggio entered the engine field in 1924 with a license for the Bristol Jupiter, to which it later added the Gnôme-Rhône 14K. In 1937–1939, Piaggio engines set 21 records, including a 17,083-meter world altitude record in the Caproni Ca.161 *bis,* but during World War II the vital high-powered engines were plagued by reliability problems.

In 1936, Pegna was replaced by Giovanni Casiraghi (1904–1984), whose experience in U.S. industry helped introduce the modern concepts epitomized in the P.108B (1939), the only four-engine bomber used by the Axis. Its effectiveness was constrained by the lack of a strategic doctrine and even more by production limited to 24 aircraft plus a dozen transport models. Other Casiraghi designs were mere technology demonstrators, so production relied mainly on licenses for Cant and other aircraft.

Postwar, Piaggio thrived on the revolutionary Vespa scooter (1946), designed by D'Ascanio using aviation technology and components. The first new aircraft was the P.136 amphibian (1948), followed by the P.148 and P.149 trainers (1951–53), the latter also built under license in Germany, and the P.166 (1957) twin-engine utility transport. In 1963, separate companies were formed for the motorcycle and aero businesses, the latter introducing the PD.808 business jet (1964) designed in association with Douglas. All these aircraft found limited use outside Italian armed forces or government agencies. The radical P.180 twin-turboprop business aircraft (1986) suffered an uncertain fate due to the early withdrawal of U.S. partner Gates Learjet in addition to a financial crisis that led the company to bankruptcy. Resurrected under new ownership as Piaggio Aero Industries, it continues to build the P.180 and participates in a number of engine programs.

Gregory Alegi

See also

Alenia; Cant Aircraft; Caproni Aircraft; Fiat; Italian Aircraft Development; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II); SIAI Marchetti

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Piasecki Helicopters

U.S. firm that helped pioneer practical use of the helicopter. It was formed in Pennsylvania in 1946 by Frank Nicholas Piasecki (1919–) to design and produce tandem-rotor helicopters.

In 1943, Frank Piasecki's P-V Engineering Forum invented and flew the second successful helicopter in the United States. Securing a Navy contract for a transport helicopter in 1944, Piasecki developed and flew the tandem-rotor XHRP-X in 1945. Needing capital to develop the helicopter, Piasecki incorporated the Piasecki Helicopter Company and attracted Rockefeller and DuPont money, which had controlling interest in the company.

The new company produced a succession of tandem-rotor helicopters, noted for their stability as loads were shifted to different points between the rotors. The Navy HRP-1 Rescuer, first delivered in 1947, was used in antisubmarine warfare tests, minesweeping tests, Marine tests of amphibious assaults, and the first long-distance rescue at sea.

From 1952 to 1954, Piasecki delivered 339 HUP-2s to the Navy. This helicopter also had tandem rotors, but the rear rotor was mounted on a high pylon to lessen the danger of the rotors clashing. This same type was procured by the Army as the H-25A Mule. The H-21 first flew in 1952. The H-16, appearing in 1953, was the largest U.S. helicopter then flying, but it was underpowered and never found military use.

In 1954, all H-21s were grounded because of design and production flaws, which led to the reorganization of the company. Needing the H-21s to service its distant early warning radar network in the Arctic, the Air Force brought pressure on the company to solve its problems. In 1950, the Rockefeller and DuPont interests that controlled the company had Frank Piasecki removed as president and made chairman of the board and head of research and development. They appointed a weak president at first, but in 1955 they appointed Don Berlin as president, and he and Piasecki clashed. Unhappy in his association with Berlin, Piasecki formed Piasecki Aircraft Company (for research) in 1956. To avoid confusion, Berlin changed the name of the original helicopter company to Vertol.

Seeing a great market in military helicopters, Vertol used its own funds to develop the new tandem-rotor Model 107. This model had a rear ramp and armor and used the dynamic components of the H-21. Needing capital to produce the 107, Vertol merged with Boeing in 1960 to form Boeing Vertol. Insisting on reliability, redundant systems, and safety, Boeing engineers also designed an efficient production line. The Model 107 became the Navy's CH-46 Sea Knight, produced from 1964 to 1971 largely for Marine troop transport.

The Army liked the CH-46 design but desired a larger helicopter. The result was the Model 114 (very similar to the CH-46), which became the CH-47 Chinook medium-lift helicopter. The Chinook was first used in Vietnam in 1965, and it made possible the Army's practice of large-scale air assaults. A very successful helicopter, the CH-47 was modernized in the 1980s, and variants continued in production in the 1990s.

Failing in the 1970s to win design competitions for the Army's UH-1 Huey follow-on or the Navy's LAMPS helicopter, Boeing Vertol changed its name in 1988 to Boeing Helicopter Company. It has focused on composite materials production for the aircraft industry and played a role in the development of the V-22 Osprey tilt-rotor and the Comanche helicopter.

John L. Bell

See also
Piasecki Helicopters
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Pilatus

Aircraft company established in 1939 in Stans, Luzern, Switzerland; represented an attempt to further develop the Swiss aircraft industry to manufacture training aircraft and supply the military. World War II slowed down any hope the company had of swift production, yet by 1944 the model SB-2, a high-wing single-engine transport, was completed, although it did not sell well. The P2, a two-seat cantilever low-wing trainer, flew successfully in 1945, at which point Pilatus was able to convince the Swiss air force of the machine's value. Following modifications, the Swiss air force took delivery of 26 P2-05s (built in part with spares from Swiss Bf 109s). In 1947, a second series of 26 machines, the P2-06, was built for use as armed trainers by the Swiss air force and served until 1981.

Though the P2 rendered great service, its capacities as a trainer could not fully prepare student pilots for the transition to jets. In response to a Swiss air force call for proposals, Pilatus went back to the drawing board, and a team came up with the P3. Although there were serious flat-spin problems that required installation of a central keel, some 73 P3s served with the Swiss air force; the Brazilian navy also ordered several machines.

The PC-6 Porter and its Turboporter variant are arguably the most successful aircraft Pilatus has produced in its own factory. First flown in 1959,the PC-6 saw service with Air America, the CIA-funded operation that operated during the Vietnam War. Still in production in 1999, more than 500 PC-6 have been built. Pilatus also produced over 320 B4 all-metal gliders in the 1970s.

Currently, Pilatus's production focuses on three products: the PC-7 Turbo Trainer, the PC-9 Advanced Turboprop Trainer, and the PC-12 single-engine transport. More than 430 PC-7s had been produced by 2001, serving with air forces as well as civilian pilot training schools. The PC-9, extrapolated from the PC-7 (later productions of both models share a modular fuselage), first flew in 1984 and is far more powerful than its predecessor, to the point where it can replace jet trainers in several capacities. Successful in several international competitions, it is also produced in the United States under license by Raytheon for fulfillment of the T-6 Texan II contract.

Finally, the PC-12's introduction in the early 1990s reflected Pilatus's goal of diversifying its production and entering the market of single-large-single engine aircraft by offering both business and cargo options. A surveillance version, the Eagle, began production in 1995.

As a means to diversify its holdings, Pilatus in 1978 purchased the British firm Britten-Norman, producer of the highly successful Islander twin-engine transport. Twenty years later, however, it sold the firm. It did, however, establish subsidiaries in the United States and Australia. As for Pilatus, the company has remained in Swiss hands but changed owners several times, from the Oerlikon-Buehrle industrial concern, then to Unaxis Holdings, and as of 2001 to a group of Swiss investors.

Guillaume de Syon

See also
Swiss Air Force; Swiss Aircraft Industry
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Piper Aircraft

U.S.-based light-aircraft manufacturer. William T. "Bill" Piper founded the Piper Aircraft Corporation in 1936, taking over the assets of the defunct Taylor Aircraft Company. The Piper Cub was Walter Jamouneau's development of R. G. Taylor's original design and was marketed with far more success, coming to dominate the light aircraft field. More than 14,000 Cubs were produced; some 5,700 saw military service as trainer and liaison aircraft.

After the war, Piper developed the basic Cub into more sophisticated variants, including the Super Cub, and then launched a long series of modern aircraft that gained widespread acceptance. These included single-engine all-metal light planes such as the Comanche and Cherokee and twin-engine aircraft such as the Apache, Aztec, Twin Comanche, and Navajo. Piper also built agricultural aircraft, such as the Pawnee and Pawnee Brave. Piper aircraft were license-built in Argentina, Brazil, and Poland.

During the early 1980s, the upsurge in product liability litigation, which hampered the activity of all light-plane manufacturers, coincided with a series of changes in Piper ownership, resulting in the shutdown of production after building more than 100,000 Piper aircraft. In 1995, the New Piper Aircraft Company was formed with the intent to revive the Piper name with a line of new aircraft, including the very advanced Malibu Mirage and Malibu Meridian.

Walter J. Boyne

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Platz, Reinhold (1886–1986)

Fokker's chief welder and production manager. At the start of World War I, Martin Kreutzer was chief designer for Fokker. Kreutzer was responsible for the successful Eindecker series and the lackluster early biplanes that followed it. Following Kreutzer's death, Fokker designs had a new look. Years later A. R. Weyl, in his 1965 book *Fokker: The Creative Years,* led the world to believe that the real talent behind the later Fokker successes—the triplane, D.VII, and D.VII fighters—was Reinhold Platz. Evidence of the trust Fokker placed in Platz was seen in his being left in charge of the German operation when Fokker returned to Holland following the war.

More recent research by aviation historian Peter Grosz has established, however, that Platz's role was limited to the initiation of engineering shortcuts intended to speed up the production process, perhaps the design of small parts, and his primary interest—welding.

The value of these skills should not be diminished, considering the need for ease and reliable rapid-production techniques in the German wartime aircraft industry, but they did not make Platz a designer. Unfortunately, the identity of the team responsible for the triplane, the D.VII, and the D.VIII remains unknown.

James Streckfuss

See also

Fokker Aircraft (Early Years)

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Ploesti Oil Refineries

Eight massive oil refineries surrounding Ploesti, Romania, that were bombed and destroyed by the Allies during World War II. The refineries supplied more than a third of the fuel needs for the Luftwaffe and Panzer corps. The first raids on Ploesti's refineries in 1941 and 1942 by Soviet and U.S. bombers were unsuccessful. After the raids, Ploesti, once an easy target, was strengthened with flak batteries, barrage balloons, and heavy fighter defenses.

On 1 August 1943, a new series of raids took place with 177 bombers launched. Crossing the Albanian coast, they ran into a large formation of cumulus clouds that split the bomb groups. When they dropped to 500 feet for their final run, German radar lost them. However, the lead element's navigator misidentified the second of three checkpoints, and other units right behind turned toward Bucharest. The trailing planes saw the error and called a warning to no avail.

Lieutenant Colonel Addison Baker, commander of the 93d Bomb Group, and copilot Major John Jersted saw Ploesti and decided on their own authority to attack. Coming in from a different direction, their new flight path brought them over the heaviest flak corridor. Fifty-two fighters attacked the bombers as they began their bombing runs. Baker's plane was hit but continued, dropped its bombs, and crashed. The two pilots received the Medal of Honor. The group reformed and found that only 15 of the original 39 planes were in the air; they had destroyed 40 percent of the plant's capacity. The most successful attack came when Lieutenant Colonel James Posey and 21 B-24s totally destroyed the Creditul Minier refinery, losing two planes.

The survivors were attacked while departing the area. Some detoured to RAF bases on Cyprus or bases in Turkey. Some ditched and were rescued. Of the 92 planes that returned, four crash-landed. Of the remaining 88, only 33 were still fit to fly. Altogether, 446 airmen were killed or captured and 106 were wounded.

Bombing reduced refinery production to 42 percent. The high loss rate meant that a follow-up mission was not practical. Although the targets were severely damaged, the plants were soon operating at premission capacity.

In the summer of 1944, B-24s, B-17s, and RAF Lancasters, now based in Italy, returned to Ploesti. After 19 missions, production capacity was cut by 80 percent. The USAAF lost 286 bombers and 2,829 crewmembers, the RAF 38 bombers and 200 crewmembers.

William Head

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POINTBLANK (1942–1945)

Allied code name for the Combined Bomber Offensive against Germany. U.S. and British air doctrine prior to the war had called for such an offensive, directed at the industrial potential of an enemy nation. This doctrine, formulated at the Air Corps Tactical School and the RAF Staff College, posited that a large long-range bomber force could disrupt and destroy an enemy's warmaking potential using high altitude daylight precision formation tactics.

POINTBLANK was ordered by the Combined Chiefs of Staff on 10 June 1943, and its top priority was the destruction of the German aviation industry so as to achieve air superiority over the continent. Simultaneously, the bombers were to strike key industries such as oil, chemicals, and ball bearings.

It was quickly realized, however, that fighter escort was necessary to protect the bombers on deep strikes into Germany. RAF Bomber Command moved to night operations. For the United States, this realization became painfully obvious in fall 1943 when unescorted U.S. bombers suffered heavy losses on missions against Schweinfurt and Regensburg.

Long-range escort fighters—the P-47 Thunderbolt and P-51 Mustang—soon arrived in theater and made their presence felt. During Operation ARGUMENT in February 1944—unofficially known as BIG WEEK—Allied bombers struck aircraft and engine factories while escort fighters severely mauled German air defenders. Air superiority was finally achieved and then maintained for the remainder of the war. The bomber offensive in turn grew in size and power and by early 1945 had destroyed much of Germany's industrial potential.

Phillip S. Meilinger

See also

Air Superiority; ARGUMENT; AWPD/1 and AWPD-42; Casablanca Conference; Combined Bomber Offensive; Doolittle, James H.; Eaker, Ira C.; Schweinfurt-Regensburg Raids

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Pokryshkin, Aleksandr (1913–1985)

Russian fighter ace during World War II. Aleksandr Ivanovich Pokryshkin was born on 6 March 1913 in Novosibirsk. He joined the military in 1932 and served as a mechanic until graduating from flight school in 1939. In June 1941, he was a senior lieutenant assigned to the 55 IAP (later 16 GIAP). By the end of the war he was a colonel commanding the 9th Guards Fighter Division. He flew the P-39 Airacobra over the northern Caucasus, Kuban, and Berlin. He flew more than 650 missions, engaged in 156 air combats, was shot down four times, and scored 59 individual victories to become the second-ranking Allied ace after Ivan Kozhedub. In addition, Pokryshkin claimed a further 13 victories that could not be confirmed because he scored them during missions in the German rear.

Pokryshkin was also a tactical innovator and teacher. He was one of the earliest Soviet pilots to switch from the three- to the four-aircraft formation and taught the formula *height-speed-maneuver-fire.* In 1943, he introduced the Kuban Ladder formation of fighters in stepped echelon, still used successfully by the Vietnamese three decades later, and he pioneered aggressive free-hunt missions. He received his first Hero of the Soviet Union on 24 May 1943 and his second five months later; on 18 August 1944 he became the first person to be awarded a third. After the war he held a number of responsible positions and was promoted to marshal in 1972, retiring in 1981. Pokryshkin died on 13 November 1985.

George M. Mellinger

See also

Kuban Air Battles

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Poland, Aircraft Development and Production

Until 1927, the Polish air force was equipped entirely with aircraft designed in other nations and, for the most part, built elsewhere. However, two Polish factories, Samolot in Poznan and Podlaska Wytwornia Samolotow (PWS) in Biala Podalska, constructed aircraft from designs of other nations. These included Hanriot H.D. 14 trainers, as well as Potez 15A2 and 27A2 reconnaissance planes. French engineers were on hand to supervise the work and train personnel. These were built in fairly large numbers, with about 750 being constructed between 1924 and 1926.

The first indigenous combat aircraft to be designed and built in Poland was the Zalewski WZX, a conventional biplane that clearly showed its French heritage and first flew in August 1926. PWS produced a large number of designs, including trainers, transports, and fighters and was a major factor until about 1934, when it began building licensed designs and slowly faded from the scene.

At about this time, the Polish air force was reorganized and the concept of combat brigades was introduced, a system not unlike the modern USAF Air Expeditionary Force. The combat brigades were to have fighter and bomber regiments and report directly to the commander in chief of the Polish armed forces. By 1926, Poland's large and well-equipped air force was second only to France in Europe.

By 1927, another aircraft manufacturer, Lublin, was contributing new designs, and another, Bartel, began manufacturing the M.4a primary and M.5a intermediate trainers. Poland also began its own aircraft engine industry with the establishment in 1927 of the Polish Skoda Works, where both the Lorraine Dietrich and Jupiter radial engines were manufactured.

It was also in 1927 that a new organization came into place—PZL (Panstwowe Zaklady Lotnicze, or National Aviation Establishments). PZL was to specialize in metal aircraft construction and soon began producing some of the most exciting aircraft of the time.

In 1928, Zygmunt Pulawski laid down the basic outline of the P-1, an all-metal fighter. Pulawski was a graduate of the Warsaw Technical University and a first-rate engineer. It was not until 1931, however, that the first of his Jupiter-powered P.7a monoplane fighters entered production. By 1933, Poland was the first country in the world to be armed entirely with all-metal monoplanes. The P.7 was immensely popular with its pilots and received attention all around the world; it replaced the PWS 10 in service.

The P.7 was developed successively into the P.11 and then an export version, the P.24. These PZL fighters were comparable to any in the world at the time of their introduction but were still in service when the Germans attacked in 1939. PZL also built a light bomber, the P.23 Karas, and a twin-engine bomber, the P.37A Los. It also had other, more advanced designs in work when the war began.

Tragically for Poland, its air force was now obsolete and unable to cope with the invaders. Many members of the Polish air force escaped to France and England, where they distinguished themselves with skill and bravery.

After the war Poland became a Soviet satellite and its air force was equipped with Soviet aircraft. In time, however, indigenous Polish designs began to emerge, including the LWD Junak, a primary trainer. Polish factories were reconstituted to build Soviet designs, including the MiG-15 fighter (as the LiM-2). The largest plant was WSK-Mielec, which has produced almost 20,000 aircraft since 1948, the great majority of them Antonov An-2 biplanes. The WSK-Swidnik plant concentrated its efforts on building helicopters of Soviet design.

PZL returned to active manufacturing in 1955 and produced a series of influential aircraft, particularly in the agricultural field. It also built the first Polish jet, the TS-11 Iskra trainer, powered by an indigenous 2,200-pound/thrust SO-1 turbojet engine and first flown in February 1960.

The Polish aviation industry has survived World War II and 46 years as a Soviet satellite; it is well positioned to meet the challenges of the future.

Walter J. Boyne

See also
PZL Aircraft

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Polikarpov, Nikolai N. (1892–1944)

Leading Russian aircraft designer during the 1920s and 1930s. Nikolai Nikolaevich Polikarpov was born on 8 March 1892 and worked as a junior designer before the revolution. After the Russian civil war, his first major task was the manufacture of the R-1 biplane, a copy of the de Havilland D.H. 9. This was the first mass-produced aircraft in the Soviet Union, about 3,000 of which were produced from 1920 to 1932. The R-1 was also the first Soviet aircraft exported to the Third World, several examples going to Persia and Afghanistan during the 1920s. Polikarpov became one of two leading designers in the Soviet Union, specializing in production of single-engine aircraft; Tupolev concentrated on large airplanes. In 1929, he was arrested on trumped-up charges and while confined in a special prison designed the I-5 fighter. In 1933, Polikarpov was released and made director of his own design bureau. He gained Stalin's patronage and continued to work until dying at his desk on 30 July 1944. In addition to the R-1, five of his designs became famous during the 1930s.

The U-2 (Uchebnyi trainer) was a biplane trainer capable of about 90 mph, redesignated Po-2 in honor Polikarpov after his death. It was so successful that more than 33,000 had been built in 59 different versions when production ceased in 1952. During the desperate days after the German invasion of World War II, it was used as an emergency night-bomber but proved so successful that it remained in service in large numbers throughout the war, equipping more than 100 regiments, the most famous of which was the women's 46 GvNBAP (Guards Night Bomber Aviation Regiment). It was again used in this role during the Korean War.

Almost as successful was the R-5 single-engine biplane bomber-reconnaissance aircraft, which entered production in 1930. By 1937, when production ceased, 6,727 had been built, including civilian versions and other variants heavily modified as armored ground attack and torpedo aircraft. It saw significant use as a day-bomber in Spain and China and was again used as a light bomber after 1941 until replaced by the even older and slower U-2.

The I-15 biplane fighter was designed with a gull wing, and several hundred were produced from 1934 to 1936 before Polikarpov reverted to a conventional straight wing for the I-15 *bis* (also I-152) version, produced in 2,408 copies from 1937 to 1939. About 155 I-15s were sent to Republican Spain, which also produced some local examples, together with a few of the later I-15 *bis.* In Spain the I-15 was called the "Chato" (Flat-nose) by the Republicans and "Curtiss" by the Nationalists, who incorrectly believed the design must have been copied by Soviet engineers incapable of such work themselves. About 270 I-15 *bis* were sent to China during the late 1930s. They were badly mauled over Khalkin Gol and Finland, and by 1941 they were of use for little more than ground attack; the few survivors were retired from service. The I-153 was essentially a derivative of the basic family, reverting to the original gull wing but adding the innovation of retractable landing gear. It entered service in 1939 and, contrary to some claims, never flew over Spain. It first saw action over Khalkin Gol. It was modestly successful at first, chiefly due to surprise, but as soon as the Japanese learned to recognize it they proved that the concept was outdated, a lesson taught again by the Finns and then the Germans. Still, 3,437 examples were produced, and it remained in service until 1943.

The I-16 entered service in 1934 alongside the I-15 and remained in service until 1942, with 10,292 produced. Its appearance in Spain (217 sent) surprised everyone, and it was the most effective fighter until the Bf 109B arrived. It was called the "Mosca" (Fly) by the Republicans and the "Boeing" or the "Rata" (Rat) by the Nationalists. It appeared in large numbers over China, then fought over Khalkin Gol and Finland. At the time of the German invasion, it provided more than half the Soviet fighter strength, and most Soviet aces flew it at some time in their careers. It remained in service on secondary fronts until 1944.

George M. Mellinger

See also

Khalkin Gol Air Battles; Night Witches; Soviet Volunteer Pilots

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Polish Air Force

During World War I, many Poles were drafted into Russian, Austrian, and German aviation units. The conclusion of World War I marked the beginning of many independent air forces around the world, including Poland. Poland's air force was created from the Polish army under General Józef Haller. In 1916, the German and Austro-Hungarian governments granted a constitution similar to the duchy of Warsaw to the territory of Poland under their control. Because of this constitution, Poles fought against Russia until the Russian Revolution when, on 3 March 1917, Polish leader Józef Pilsudski formed several legions of his own and fought to recover Polish provinces in foreign hands. Despite being thrown into prison for refusing to order his troops to fight with the Germans, Pilsudski and his troops prevailed after the Brest-Litovsk Treaty, when Austrian/German domination collapsed and Russia renounced their hold on the Polish territories. The Riga Treaty ended warfare on 18 March 1921.

The Polish army corps had an aviation squadron in 1917 filled with pilots who had trained and served in the Russian, German, and Austrian air forces. The squadron was part of General Jozef Haller's XI Corps. Two of these pilots were the first Poles to obtain a license. General Haller also sent pilots for training in Dijon, France, in the summer of 1918. By 23 March 1919, there were 88 Polish pilots, three observers, two technical officers, and 110 airframe and engine mechanics. They had acquired a total of 60 aircraft by this time. (Poland's first aircraft factory and school had been founded in Warsaw in 1910 and a year later had produced 12 airplanes, but whether the factory and school were still functioning by the end of World War I is not known.) Six months later, on 29 September 1919, General Haller inaugurated Poland's separate air force. With this force, Poland fought against Russia.

After World War II, many Poles fled the now communist-occupied territory. The former Polish flying units were assembled into Soviet units. In 1956, all Soviet personnel were removed and the new Air Defense Force, a missile-based independent air arm, was created. By 1990, these two forces merged into a single force: the Polska Wojska Lotnicze I Obrony Powietrznej (Polish Air Force and Air Defense Force).

In 1999, a decade after the fall of the Soviet Union, Poland became a member of NATO. It still flies equipment derived from Soviet and Russian sources.

Wendy Coble

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Polish Auxiliary Women's Air Force Service (1943–1945) and [British] Air Transport Auxiliary (1941–1945)

The Pomonicza Lotnicza S-UBA Kobiet (PLSK; the Auxiliary Women's Air Force Service), founded by order of the minister of defense of the Polish government-in-exile on the model of British Women's Auxiliary Air Force to replace Polish servicemen in support roles on Polish air bases in the United Kingdom.

Initially, 36 women candidates were sent in May 1943 for basic training to Falkirk, Scotland. The group qualified as instructors, of whom 12 became officers and were awarded both Polish and British ranks in October 1943. General recruitment to PLSK began in November 1943, including Polish women from Canada, the United States, France, Argentina, Switzerland, China, and Japan. Many volunteers came from Polish units evacuated from the Soviet Union to the Middle East.

Serving in 26 units of the Polish air force, personnel were trained in 45 specialties. One Polish source estimates the total strength of PLSK at 1,436, constituting 10 percent of Polish air force strength in the West and including 52 officers and 110 NCOs (an earlier source cites a total of 1,653, including 52 officers and 163 NCOs).

In addition, three Polish women served with the British Air Transport Auxiliary (ATA): Anna Leska-Daab, Jadwiga Pilsudzka, and Barbara Vojtulanis. RAF Flight Lieutenant Leska-Daab was the sole woman flying with ATA (1941–1945) to receive the Royal Medal. She became flight leader in the spring of 1943 and was placed in charge of eight women ferry pilots—five British and one each from the United States, Chile, and Argentina. Stationed at Hatfield and Hamble, she ferried 93 types of aircraft and amphibia and logged 1,241 hours in the air.

Kazimiera J. Cottam

See also

Lewandowska, Janina; Sosnowska-Karpik, Irena

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Portal, Charles (1893–1971)

RAF air chief marshal, British military leader during World War II, one of the main architects of the Allied victory in the air war in Europe. He was a devoted champion of Anglo-American strategic interdependence and cooperation. Charles "Peter" Portal was born on 21 May 1893 at Eddington House near Hungerford. He was educated in Winchester and Christ Church, Oxford.

During World War I, Portal served in the Royal Engineers and Royal Flying Corps (since 1915). He participated in more than 900 operational sorties and finished the war with military decorations as lieutenant colonel.

Portal's distinguished career in the RAF since its creation in 1919 won him numerous decorations and honors as well as promotion to all ranks, as high as acting air chief marshal (1940), and Marshal of the RAF (1944). During the interwar period, he spent some years training and took staff positions at the RAF Cadet College and Imperial Defense College. Portal commanded a bomber squadron (1927–1939) and British forces in Aden (1934–1935), where he succeeded in air-policing of hostile tribes.

In 1931–1933 and 1937–1939, Portal took various positions at the Air Ministry, handling RAF organization, expansion, and improvement of its combat effectiveness.

As a head of Bomber Command (1940) and Chief of Air Staff (1940–1945), Portal revolutionized RAF technology, strategy, and tactics including area- and night-bombing of Germany. He also presided over the spectacular RAF victory in the Battle of Britain, as well as the course of war in Europe.

Charles Portal coordinated the Combined Bomber Offensive against Germany with dramatic success, although his compromise with the U.S.-promoted precision air strikes on German targets brought him into conflict with Arthur Harris, who strongly favored sustained area-bombing. Widely admired for his tremendous cooperation skills, Portal also contributed greatly to common strategic decisions at the Allied conferences in Casablanca, Washington, and Quebec.

Portal retried from the RAF in 1945 and took a number of civilian positions, including chairman of British Aircraft Corporation (1960–1968). Portal, First Viscount of Hungerford, died of cancer at West Ashing House on 22 April 1971.

Peter Rainow

See also

Britain, Battle of; Casablanca Conference; Combined Bomber Offensive; Radar; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Ruhr Bombing Campaign; Strategic Bombing; World War I Aviation; World War II Aviation

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Porte, John C. (1884–1919)

British pilot; helped develop the early flying boats. Born on 26 February 1884 in Bandon, County Cork, Ireland, Porte entered service with the HMS *Britannia* in 1898 and, after initial training, joined the submarine service, receiving his first command in 1908. In 1911, Commander Porte was diagnosed with pulmonary tuberculosis and invalided out of the Royal Navy.

Porte became interested in aviation in 1910. After retiring, he obtained his pilot's license. He became technical director and test pilot for the newly formed British Deperdussin Company and also won acclaim in racing and display flying. After the company, failed he worked for the White and Thompson Company as a test pilot.

In April 1914, Porte joined Curtiss as a pilot. He helped redesign *America,* the Curtiss flying boat designed to win the *Daily Mail*'s £10,000 prize for the first transatlantic flight. When war came in August, he offered his services, despite his tuberculosis, and took command of the Royal Naval Air Service training school at Hendon. He also brought *America* to Captain Murray Sueter's attention, leading to substantial British Admiralty orders for the type.

Porte became commander of Felixstowe Naval Air Station in 1915. He conducted many experiments with the early Curtiss boats to improve their performance. He successfully combined engineering design with combat flying, giving him instant operational feedback. His development work generated later larger Curtiss products and the famous Felixstowe type that was the ancestor of most flying boats developed in Britain, Japan, and the United States.

Porte died in 1919 from his tuberculosis.

Paul E. Fontenoy

See also
Flying Boats; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Sueter, Murray

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Potez 25

French single-seat aircraft of high performance. Few visitors to the ninth Paris Air Show in 1924 paid any heed to the single-engine biplane Potez 25 A2 on display, preferring instead to focus on the Breguet 19, which had earned several endurance records. Yet the Potez, although smaller, had already surpassed the Breguet.

Built of wood and metal, this two-seater could be powered by any number of 400–500-hp engines. Tough and easy to maintain, the aircraft was ideal to undertake a variety of civilian and military tasks. Sponsoring a series of advertising long-distance flights, the Potez firm eventually received orders from some 15 air forces, including a total of over 2,400 machines for the French air force, delivered from 1926 to 1934. The machine was manufactured in four French factories, and production licenses were also granted to Poland, Portugal, Romania, and Yugoslavia.

The versatility of the aircraft led to multiple records, including the 1926 distance record of 4,305 kilometers. Its altitude capacity (the only single-engine aircraft of its kind to be able to reach over 21,000 feet) prompted the French airline Aéropostale to purchase several for its Andes postal link. Overall, some 3,500 machines in 87 different variants were built. Although technically obsolete by the 1930s, some saw service in the Spanish civil war. The longest-serving aircraft were stationed in French Indochina until 1945.

Guillaume de Syon

See also
Potez Aircraft

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Potez 63

In October 1934, the French air force issued a requirement for a three-seat aircraft for use as a command, reconnaissance, and interception fighter that would be equipped with two 20mm cannons. Potez's entry, Model 63 #1, first flew on 25 April 1936. Built entirely of light alloys, its performance prompted the air force to give the go-ahead for a series of 10 prototypes intended to help define further the operational envelope and purpose of the plane. Several of these became two-seaters, including the prototype versions of ground attack, bombing, and night-fighter versions. Total production of the 63 reached 1,684, including construction of the Model 630, of which 84 were built, and the Model 631.

The Potez 631 constitutes the first dedicated night-fighter, which was used according to interception protocols adopted in 1934 and still in effect at the beginning of World War II. During the so-called Phony War that lasted through May 1940, Potez 631 crews underwent nighttime training.

Intending to match the Messerschmitt Bf 110, these aircraft nonetheless lacked sufficient engine power and armament. Several documented instances note that instead of two 20mm cannons, some aircraft only had one, while the second was replaced with a 7. mm machine gun. With the beginning of the German offensive, the Potez-equipped squadrons took off nightly to intercept German bombers. The first confirmed victory for the night-fighters came on 18 May, when a 631 downed a Heinkel He 111 bomber. Overall results of such sorties were disappointing, however, as the 631 showed its weakness in a lack of proper protection and insufficient armament. In addition, night-fighting operations lacked proper infrastructure and training for non-Potez crews. Consequently, both French antiaircraft defenses and non-Potez crews were prone to mistake the 631 for Messerschmitt Me 110s, thus leading to death by friendly fire. This prompted a change in the decoration of the planes to include a long white stripe on each side of the fuselage.

Meanwhile, under the conditions of the massive German attack into French territory, the 631-equipped squadrons were turned into daytime-fighters, and the planes received a further two machine guns under each wing. This, however, affected overall performance, which was already suffering from limited engine performance, and many planes were lost. By the time the armistice went into effect on 25 June 1940, some 400 Potez 63s had been destroyed. After the cease-fire, several squadrons were incorporated into the Vichy air force, but by 1943 these squadrons had switched to other aircraft.

Guillaume de Syon

See also

Potez Aircraft; Vichy French Air Force

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Potez Aircraft

French aircraft manufacturer. Born in 1891, Henri Potez graduated in 1911 from the French aeronautical engineering school. During World War I, Potez worked with Marcel Bloch (later Dassault) on standardizing production of the Caudron G.3 and on the design of a new propeller. Together, along with engineer Louis Corroler, they then founded SEA, an aeronautical design company that obtained a contract for the development and production of a trainer. The end of World War I blocked further development, but Potez offered aircraft out of his own factory, founded in 1919. The Potez works produced several highly popular machines, including the Potez 25 and Potez 36.

Potez also built the notorious Model 54 (540) in 1933, a bomber that also existed as a 14-passenger civil version. It also built several civil aircraft, some of which established performance records. As of 1936, Potez controlled five aircraft factories, which were nationalized and formed the northern group of government factories. Potez agreed to preside over them. By the time World War II started, Potez's works had produced 40 prototypes and 7,000 aircraft, including some 1,300 commercial and civil machines. The most important of these was the Potez 63 twin-engine aircraft. Potez resigned from the directorship in 1940 but continued to administer the group until his arrest and brief detention by German authorities in 1942. After the war, his engine division began work immediately, but Potez did not return to aircraft design until 1952.

That year, convinced that he needed to offer an aircraft capable of ground attack to support ground troops, Potez ordered the development of the Model 75. This heavily armored single-engine pusher proved remarkably capable when it was first tested in 1953, but it failed to sell and was cancelled five years later.

In the postwar years, the Potez group was able to survive through diversification that included a series of joint productions and subcontracts. These included the acquisition in 1957 of the Air Fouga firm, which produced the highly successful CM-170 Magister jet trainer.

Henri Potez attempted to market the Potez 840 beginning in 1960. This four-engined turboprop was intended for short-haul links from regional airports. First flown in April 1961, the firm reportedly obtained an order for 120 machines from a U.S. company, Turboflight. In fact, the contract was not fulfilled, even though Henri Potez went so far as to set up a factory in Ireland to produce the machine. Consequently, only four such aircraft were built beyond the two prototypes.

One of the last Potez projects was a cooperative venture with the Heinkel firm in Germany to produce the CM-191, a four-seat VIP version of the CM-170 Magister. The project failed, and only two prototypes were built. Disappointed with the shortcomings of his last projects (the Model 75 and Model 840 in particular), Potez met with representatives of Sud-Aviation (later Aérospatiale-Toulouse) on 3 April 1967 and signed a contract that transferred the Potez holdings to the state company. Potez then spent the rest of his life in quiet retirement until his death on 9 November 1981.

Guillaume de Syon

See also

Potez 25

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Powers, Francis Gary (1929–1977)

U.S. reconnaissance pilot shot down while flying a CIA U-2 over the Soviet Union, Francis Powers; the incident became one of the enduring symbols of the Cold War.

Powers was born in Burdine, Kentucky, on 17 August 1929, the second of six children born to Oliver and Ida Powers. Although the Powers family was usually poor, young Francis worked hard to get an education and graduated from Milligan College in 1950. Enlisting in the Air Force that October, Gary Powers (as he was known at the time) was trained as a photo technician.

Powers was accepted as an aviation cadet in November 1951, and he received his commission and wings 13 months later. He was assigned to Turner AFB, Georgia, where he flew the Republic F-84. He was highly regarded as a pilot and considered one of the best gunners in the wing. While in the Air Force he married Barbara Gay Moore.

Powers left the Air Force for the CIA in 1956 and began training at a secret base in the Southwest, learning to fly the Lockheed U-2. He went on to fly 27 missions, including several overflights of the Soviet Union, before his last fateful flight.

On 1 May 1960, Powers took off from Peshawar, Pakistan, for a planned overflight of several high-priority targets in the Soviet Union. Near Sverdlovsk, where he was flying at 70,000 feet, Soviet air defenses scrambled interceptors and fired a salvo of 14 SA-2 missiles at the U-2. Shockwaves from a nearby missile explosion blew the tail off the aircraft, and Powers parachuted onto a collective farm, where he was immediately captured.

Charged with espionage and subjected to a show trial in Moscow, Powers was sentenced to 10 years in prison. He passed the time in jail by keeping a diary, writing home, and knitting rugs. On 10 February 1962, he was exchanged for Rudolf Abel, a KGB colonel who had been arrested and imprisoned in the United States.

Powers took a desk job with the CIA upon his return, but office work bored him and he soon accepted an offer from the Lockheed Skunk Works. There he test-flew U-2s that had returned to Lockheed for maintenance or modification.

His marriage to Barbara ended in divorce soon after his return from the Soviet Union, and he married Claudia "Sue" Downey in October 1963. The following August he adopted Claudia Dee, Sue's daughter by a previous marriage, and in June 1965 Francis Gary Powers Jr. was born.

His job with Lockheed ended in October 1969, and he eventually found work as a traffic reporter for a Los Angeles radio station. Moving on to television in 1976, he learned to fly helicopters and covered weather, fires, and police chases from a Bell Jet Ranger.

During a flight on 1 August 1977, his engine failed due to fuel exhaustion. He attempted an emergency landing, but he swerved to avoid a group of children on the ground and the helicopter crashed, killing him instantly. Francis Gary Powers was buried at Arlington Cemetery.

Mark E. Wise

See also

Lockheed U-2; Republic F-84 Thunderjet/Thunderstreak

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Precision-Guided Munitions

Highly accurate aerial weapons. Precision-guided munitions (PGMs) are any of a variety of accurate firepower systems that use midcourse guidance to hit targets with single-round efficiency. Although guidance techniques vary, most PGMs fit into one of three categories. *Correlation guidance* involves the map-reading and terrain-matching capabilities typical of long-range cruise missiles. *Precision-fixing weapons* use synchronized beacons from ground stations or navigational satellites to steer to a target. And *seeker guidance,* including laser designation and electro-optical television guidance, allows a projectile to home in on natural or induced electromagnetic signatures.

Efforts to develop PGMs began as early as 1917. However, for the next 50 years attempts at precision—including the use of gyroscopic guidance in World War I and radio control in both World War II and Korea—met with very limited success, and these primitive guided weapons saw little action. During the early bombing campaign in Vietnam, in 1965, it quickly became obvious that greater bombing precision was still needed, and military authorities commissioned a variety of projects intended to make bombing more effective and less costly in terms of both lives and dollars. Incorporating newly developed technologies, including lasers and large-scale integrated circuitry, the Air Force's Paveway Task Force developed an effective class of terminal-guided munitions, using laser and electro-optical seeker technology. When tested in Southeast Asia in 1968, Paveway PGMs recorded an unprecedented circular error probability of just 20 feet, with fully one in four bombs scoring direct hits. Used extensively during the LINEBACKER air campaigns of 1972, PGMs produced unprecedented results. For example, on 13 May 1972, F-4 aircraft armed with laser-guided bombs destroyed the infamous Thanh Hoa Bridge, accomplishing in a single mission what seven years and 869 nonprecision bombing sorties had failed to achieve.

Since their full capabilities were first demonstrated in Vietnam, so-called smart weapons have worked a virtual revolution in warfare. U.S. policymakers have come to rely on PGMs, with their promise of reduced collateral damage and danger of escalation, as a humane military option applicable in a wide variety of crises. The 1991 Gulf War, with its vivid TV news coverage of precision air strikes, clearly demonstrated the benefits of single-bomb target destruction. The result has been a trend toward increased reliance upon precision weapons. Thus, whereas only 8 percent of the total bombs dropped during the Gulf War were precision-guided, fully 98 percent of those used by the U.S. military in the Balkans, DELIBERATE FORCE in 1995, and ALLIED FORCE in 1999 were PGMs. The newest generation of precision weapons intertwines seeker guidance with precision-fixing Global Positioning System satellite links to give virtually every U.S. warplane in the inventory precision capability.

The U.S. airstrikes in Afghanistan in the war against terrorism unleashed the entire menu of PGMs against a range of targets.

Paul G. Gillespie

See also

Aircraft Armament; Gulf War; Missiles, Air-to-Surface; Vietnam War

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Preddy, George E., Jr. (1919–1944)

World War II fighter ace. Major George Preddy was the third-ranking U.S. fighter ace in the European Theater of Operations (ETO) and the highest-scoring U.S. ace in Europe to lose his life in action. Born in Greensboro, North Carolina, Preddy graduated from flight training in December 1941. His first assignment was with the 49th Fighter Group stationed in Australia. After flying a number of missions, he was seriously injured in a midair collision and returned to the United States to recuperate.

In December 1942, he joined the 352d Fighter Group of the Eighth Air Force, flying with the 487th Fighter Squadron, commanded by future ace John C. Meyer. Flying the Republic P-47 Thunderbolt, Preddy flew his first mission in the ETO in September 1943. Three months later, he scored his first aerial victory, a Messerschmitt Bf 109.

In April 1944, the 352d traded in its Thunderbolts for the new P-51 Mustang long-range fighter. Soon afterward, Preddy achieved his fifth confirmed victory. Within a few months, he had become one of the leading aces in the ETO. He completed his 200-hour combat tour, and then four successive 50-hour extensions, as his victory tally mounted. On 6 August 1944, flying his distinctive Mustang *Cripes A' Mighty,* Preddy shot down six Bf 109s in a single mission—the first U.S. fighter pilot to accomplish that feat.

In November 1944, after taking leave in the States, Preddy rejoined the 352d Fighter Group, but this time as commander of the 328th Fighter Squadron. On Christmas day, flying out of Asche, Belgium, Preddy downed two enemy aircraft, bringing his score to 26.83 victories. Sighting a Focke-Wulf Fw 190 trying to escape far below, Preddy dove to the deck after him. Skimming over U.S. ground troops in hot pursuit of the enemy aircraft, *Cripes A' Mighty* was mistakenly hit by friendly fire and Preddy was instantly killed in the ensuing crash.

As the leading active ace in Europe at the time of his death, it is likely that if not for this tragic error Preddy would have soon become the ETO ace of aces. Instead, he died the sixth-ranking U.S. Army Air Forces ace of World War II and the eighth-ranking U.S. fighter ace of all time. His brother William, also a Mustang pilot with the Eighth Air Force, was killed in action only a few months later. George Preddy's decorations included the Distinguished Service Cross and the Silver Star with one Oak Leaf Cluster.

Steven A. Ruffin

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Presidential Aircraft

Famous among civilians today as Air Force One; 12 U.S. presidents have flown aboard these specially modified airplanes.

Transports

The first aircraft outfitted specifically for use by a president was a C-87A Liberator Express, an adaptation of the B-24 Liberator bomber.

The C-87A was a VIP transport version of the no-frills C-87. Designed for passenger comfort, it was fitted with 16 Pullman-type upholstered seats that could be converted into five berths. It had a maximum speed of 220 mph and a cruising speed of 188 mph. Its range was 3,300 miles with a service ceiling of 28,000 feet.

Six C-87As were built. Serial number 41-24159 was designated as the presidential aircraft, underwent additional modification, and was renamed the *Guess Where 2.* Eleanor Roosevelt used it for a trip to Central and South America (however, the president was never aboard). In 1945, the *Guess Where 2* was scraped.

Since the Douglas C-54 Skymaster had proved to be one of the world's safest and most reliable aircraft, the U.S. Army contacted Douglas for a special version for the president. The VC 54-C serial number 42-107451 provided for President Franklin Roosevelt had a cruising speed of 250 mph, a range of 3,900 miles, and a service ceiling of 22,300 feet. It carried a crew of seven and could accommodate 15 passengers. A conference room was provided with a large desk and an elevator behind the cockpit to lift the president in and out of the aircraft.

Roosevelt preferred travel by ship or train and made only one round-trip aboard *Sacred Cow,* as it was nicknamed, to attend a conference in Yalta with Churchill and Stalin. Roosevelt traveled to Malta aboard the cruiser USS *Quincy.* From there on 3 February 1945 Roosevelt flew aboard *Sacred Cow* to Saki (near Yalta). On 12 February *Sacred Cow* returned the president to the USS *Quincy* at Cairo.

President Harry Truman loved to fly and would keep the crew of *Sacred Cow* busy. Truman did not reserve *Sacred Cow* for his use only. Among those who used the aircraft were General George C. Marshall, Secretary of State James F. Byrnes, Winston Churchill, former President Herbert Hoover, China's Mme. Chiang Kai-shek, and others. At Truman's urging, General Dwight Eisenhower used *Sacred Cow* when returning from Europe to a hero's welcome.

On 26 July 1947, Truman signed the National Security Act of 1947 while aboard *Sacred Cow.* This act established the Defense Department and created the U.S. Air Force as an independent service. Later that month, *Sacred Cow* was retired as the primary presidential aircraft. On 4 December 1961, ownership was transferred to the Smithsonian Institution, and it is now on display at the Air Force Museum in Dayton, Ohio. In 1946, the Air Force purchased a Douglas DC-6 with the military designation VC-118 to replace *Sacred Cow.* The aircraft was named *Independence,* in honor of Truman's Missouri hometown.

The next presidential aircraft was a Lockheed Constellation, which Air Force officials mistakenly thought would be used by the expected winner of the presidential election, Thomas E. Dewey. Lockheed modified one of the Constellations on the production line and gave it special features suitable for a president. Air Force serial number 48-608 with the unofficial name *Dewdrop* was delivered to the embarrassed Air Force. Truman was aware of the blunder, and when the aircraft was offered he refused it. Someone had given Truman a mustache cup (Governor Dewey wore a mustache). Truman gave the cup to the Air Force and ordered that it be displayed in the cockpit of *Dewdrop. Dewdrop* never would fly as Air Force One, however, it did make several flights as backup to *Independence.*

A Boeing 707 was selected next, succeeded by a Boeing 747. Two identical 747s are used today as presidential transports. When the president is aboard either aircraft (or any Air Force aircraft), the radio call sign is "Air Force One." When the vice president travels on one, the call sign is "Air Force Two."

The "Air Force One" call sign was first used in 1959 after confusion arose between an Eastern Airlines flight and the president's aircraft. The president's aircraft could have had a serious accident, so from then on any aircraft the president was flying in became known as Air Force One.

The current Air Force One, a 231-foot-long Boeing 747-200B, was delivered in 1990 to President George H.W. Bush. It has an office for the president, a conference room that is as large as the one in the White House, a dining room, and sleeping quarters for the president and first lady. The president's bedroom has twin beds and a bathroom with a shower. Guests, senior staff, Secret Service personnel, and the news media have separate accommodations. Air Force One has leather seats, wood-grain furniture, and paneling similar to what is found in the White House. Next to the president's office is a medical room, complete with an operating table and equipment to treat medical emergencies.

Air Force One can fly 9,600 miles without refueling. It has almost as much communications equipment as is in the White House. There are 85 telephones, 57 antennas, 19 television monitors, 11 videocassette players, and several computers that communicate with computers on the ground. There are more than 230 miles of electrical wiring, more than twice the amount in a normal 747. The communications equipment permits the president to get information from satellites and communicate with submarine commanders. Air Force One has two galleys that can provide up to 100 meals at one sitting. Freezers hold enough food for a week. In an emergency, with aerial refueling, the president could live on the aircraft for seven days.

Air Force One also carries top-secret military equipment. It has electronic equipment that can jam enemy radar and other communications. The crew can release flares to lure heat-seeking missiles away from the aircraft and release "chaff" to help hide the aircraft from radar.

Helicopters

In 1957, President Eisenhower asked his military aides about using helicopters for short trips. The Air Force and

Army aides expressed concern about the safety of helicopters. The Secret Service concluded that helicopter travel was most likely as safe for travel as the traditional motorcade. The Air Force purchased two Bell UH-13J helicopters for use by the White House.

The Bell UH-13J is the military designation for the Bell 47-J Sioux. First manufactured in 1945, the Sioux carried two passengers, had a cruising speed of 90 mph, and a range of 250 miles.

On 12 July 1957, Eisenhower flew from the White House to Camp David aboard a Bell UH-13J and became the first chief executive to travel via helicopter. This started almost weekly flights to either Camp David or to Eisenhower's Gettysburg farm.

After their White House assignment, the two UH-13Js were used to transport high-ranking Department of Defense personnel. In July 1967, both were transferred to the Smithsonian Institution. The craft that Eisenhower used to make the first helicopter flight is at the Paul E. Garber facility; the other is on loan to the Air Force Museum in Dayton.

On 1 January 1958, the U.S. Army Executive Flight Detachment, Fort Belvoir, Virginia, was activated. Along with Marine Helicopter Squadron One (HMX-1), U.S. Marine Corps Air Station, Quantico, Virginia, it was given the primary mission of the emergency evacuation of the president, his family, and other key government officials as well as providing routine helicopter transportation. When the president is aboard, the helicopter's call sign is "Marine One."

In January 1958, both the Executive Flight Detachment and HMX-1 were using the Sikorsky H-34C as the primary helicopter. The H-34C was used to transport the president while Sikorsky built the first of the VH-34Ds. The "V" designation stands for "VIP" and means that an aircraft has been modified with customized interiors and other special equipment suitable for a VIP. This designation was first used during Truman's presidency and continued until President Jimmy Carter ordered the VIP designation be dropped. However, President Ronald Reagan allowed the designation to be restored.

The VH-34D is the military transport version of the Sikorsky S-58. It was designed specifically for the U.S. Navy as an antisubmarine attack helicopter. The VH-34 carried a crew of four and could transport up to 10 passengers. It had a cruising speed of 130 mph and a range of 270 miles.

In 1961, the VH-3D Sea King began to replace the VH-34D as the primary executive transport. Developed for the Navy as a carrier-based all-weather antisubmarine helicopter, with extensive interior modifications it became the favored VIP transport. In addition to the interior improvements, many protective measures were utilized. Light armor protects the crew and passengers from small-arms fire and medium-explosive projectiles. Special protection is provided for the electrical system and flight controls. Self-sealing and crash-resistant fuel tanks, along with energy-absorbing landing gear and seating, improve crash survivability.

In 1962, President John F. Kennedy requested that the VIP aircraft have distinctive markings. The aircraft were to have a green color scheme, with "United States of America" painted on both sides of the fuselage, and the American flag on both sides of the tail. The presidential seal appears on both sides of the nose.

The VH-60N is the VIP transport version of the Sikorsky UH-60 Black Hawk first developed for the Army as a troop and cargo-lift transport. The UH-60 first flew in 1974. The VIP version has energy-absorbing landing gear and seating in an effort to increase crash survivability. It has self-sealing puncture-resistant fuel tanks with an armor-protected control system and seats. Protective armor on the Black Hawk can withstand 23mm shells. The unique interior design of the passenger cabin incorporates several conveniences that help make the flight comfortable and enjoyable. Design features include a quiet interior, large windows, special communications equipment, a refreshment galley, and a restroom.

The history of presidential aircraft does not stretch as far back as the earliest days of aviation. However, Air Force One and Marine One will continue to serve important functions during times of peace and war.

Henry M. Holden

Pressurized Cabins and Cockpits

Life-support for pilots, crews, and passengers. The need for cabin pressurization arose from the increasingly high altitudes aircraft were able to attain in the years leading up to World War II. Although crewmen in high-flying unpressurized aircraft could function by breathing supplemental oxygen, wearing oxygen masks was not always practical. Moreover, at altitudes surpassing 40,000 feet, the nearly nonexistent atmospheric pressure was found to be incompatible with life, even with supplemental oxygen. The solution to both of these problems was cabin pressurization. This would allow aircraft occupants to breathe normally at any altitude in an environment similar to that near sea level.

The first attempt at cabin pressurization—ultimately unsuccessful—was in 1920 at McCook Field, Dayton, Ohio. And though the first successful design appeared in 1928 in Germany, the true predecessor of modern pressurized aircraft was the Lockheed XC-35. This modified 10E Electra won the 1938 Collier Trophy for the Army Air Corps. During World

War II, some British and German aircraft were pressurized; the first mass-produced pressurized aircraft in the United States was the Boeing B-29. Since the war, virtually all aircraft capable of high-altitude flight have been pressurized.

Steven A. Ruffin

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Prisoners of War

Although combatants were captured and made prisoners long before the development of airpower, the advent of the airplane opened a new dimension in captivity. Aircrew POWs differ from ground or naval POWs in two respects. First, ground or naval POWs are most commonly, though not always, captured in a group, generally the same group with which they had been fighting prior to their capture. Aircrews parachuting from disabled aircraft often arrive on the ground and evade or are captured alone. This is the case even in multiplace aircraft, where aircrew members are likely to be scattered in the act of bailing out. Second, as airplanes often operate well behind the traditional front lines, troops, reserves, local police, and even armed—and often angry—civilians can capture aircrews. Their isolated nature makes aircrew POWs the most likely to be mistreated or killed, as often they are the only ones accessible to the angry populace. Such mistreatment is most likely for those who unfortunately bail out over or near their targets.

The first aircrew POWs were captured in World War I. In contrast to the mud and anonymity that characterized the front lines for ground troops, aircrews were often treated as something different—chivalric knights of the air. A captured pilot, if not injured, often enjoyed a meal in the mess of an enemy flying squadron, sometimes breaking bread with the man who shot him down before being moved to a POW camp.

In World War II, the majority of aircrew POWs went down far from the front lines and faced immediate capture in the enemy's heartland or a long and dangerous period of evasion. In contrast to World War I's chivalric code, Allied aircrews in Europe were characterized by the Nazi leadership as "terror-bombers" or "luft-gangsters." There is no way to tell how many were murdered by vengeful civilians, but accounts from POWs of being protected from such mobs by German military forces are common. Allied aircrews who fell into the hands of Nazi functionaries such as the SS or Gestapo were in for a rough time, but Hermann Goering, head of the Luftwaffe and a World War I fighter ace, clung to the notion of chivalry and did much to ensure the safety and comfort of his fellow airmen. These conditions, however, do not match those portrayed in popular movies and TV shows. Allied aircrews captured by the Japanese faced immediate execution or a life of slave labor until death or liberation. Axis aircrews who fell into Allied hands generally met humane treatment in accordance with the Geneva Convention of 1929. Soviets in German hands and Germans in Soviet hands faced barbaric treatment, no matter their service.

Following World War II, a new philosophy regarding POWs emerged. Socialist revolutionaries believed POWs were tools for furthering the revolution. They could be converted to the socialist cause or exploited for propaganda. Attempts at the former predominated in Korea, where aircrew prisoners were generally not differentiated from prisoners from other services. Attempts at the latter predominated in Vietnam, where aircrew prisoners were labeled "air pirates." The name is reminiscent of Nazi Germany, but conditions for POWs more resembled those in Japan or Korea. In the Gulf War, all Coalition POWs were mistreated, regardless of service, but the war ended relatively quickly, resulting in a short captivity.

Since World War II, search-and-rescue techniques and technology have drastically improved. The efforts of such personnel have often been able to prevent the capture of downed aircrews. These search-and-rescue efforts have taken on increasing importance, as airpower has been the first choice for military action since the Gulf War and Western political leaders have been increasingly reluctant to risk the capture and exploitation of POWs.

Grant Weller

See also

BAT 21; Combat Search and Rescue; Ejection Seats; German Air Force (Luftwaffe); Germany, and World War II Air Battles; Japan, Air Operations Against; Korean War; Powers, Francis Gary; Risner, Robinson; USS Pueblo; Vietnam War; World War I Aviation

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Propellers

Aeronautical propulsion technology. The propeller, used in conjunction with the reciprocating internal combustion piston engine, was the main form of aerial propulsion for the first 50 years of heavier-than-air flight.

Propellers are essentially a series of twisted airfoils, or blades, connected to a central hub that convert through helical motion the energy supplied by its power source. The blades strike the air at a certain angle (pitch) and generate thrust by creating an area of high pressure behind the propeller, which pushes the airplane forward. The continued refinement of the propeller exhibited the strong interrelationship between technology and airpower doctrine.

The development of the propeller is firmly connected to the development of airpower. When the airplane emerged as an important military weapon during World War I, fixed-pitch propellers were simple in operation, efficient for one operating regime, and gave adequate performance for aircraft that operated at low altitudes. For propellers to be efficient enough to contribute to the overall performance and military mission of the airplane, engineers needed to develop a variable-pitch propeller, which allowed the pitch at which each propeller blade rotated through the air to vary according to different flight conditions.

Military aeronautical research facilities in Europe and North America fostered this development during the war and on into the interwar period. In the United States, where the first practical variable-pitch propellers were introduced in 1932, the Army employed leading propeller engineers, built the required testing facilities, determined the engineering standards, and issued the production contracts that supported a growing U.S. industry.

By the outbreak of World War II, engineers had introduced the constant-speed propeller, which changed blade pitch automatically according to varying flight conditions while the engine speed remained the same. These propellers provided more responsive control of pitch variation. They facilitated multiengine synchronization for bombers and transports and removed the risk of fighter aircraft "overspeeding" the engine while diving. Another major feature was its ability to "feather," which positioned the blades to prevent propeller windmilling after engine failure. As a result, constant-speed propellers played a key role in the aerial campaigns of World War II.

The Allies manufactured approximately 1 million high-performance propellers for the war effort with more than 75 percent of that total being propellers designed by the Hamilton Standard Company of East Hartford, Connecticut.

The advent of jet technology during World War II meant the propeller would play a lesser role in the postwar period, but the propeller-driven airplane would remain valuable in transport, observation, and tactical operations. The combination of the variable-pitch propeller with the gas turbine resulted in the turboprop, which increased propulsive efficiency, fuel economy, and generated less noise. The highly successful turboprops Lockheed C-130 Hercules and P-3 Orion began military operations in the mid-1950s.

Jeremy R. Kinney

See also

United Aircraft Corporation; Wright-Patterson Air Force Base

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Pueblo, USS

U.S. surface vessel that was attacked by North Korea in 1968. Some seven months after the Israeli attack on the USS *Liberty,* another U.S. intelligence-gathering ship came under hostile fire. On 23 January 1968, USS *Pueblo* was conducting electronic-intelligence and oceanographic operations in international waters approximately 15 miles off the coast of the Democratic Republic of Korea. North Korean naval vessels approached the *Pueblo* with intent to board her. When *Pueblo* refused, the North Korean vessels opened fire, ultimately killing one crewmember. *Pueblo* finally surrendered to the North Korean vessels and proceeded to the harbor at Wonson, where the crew was interned. As with the *Liberty,* the *Pueblo* did not benefit from the prompt protective cover of U.S. naval or aerial forces, which some critics argue was an inherent betrayal of all U.S. intelligence-gathering forces. Indeed, some extremist views hold that *Pueblo* was intentionally compromised in an elaborate U.S. scheme, although such claims are wholly unproven. Although the Korean attack was an isolated instance of aggression, U.S. policymakers feared it was a harbinger of a broader communist expansion in Asia, concurrent with the surprise Tet Offensive in Vietnam. As such, the United States quickly strengthened its military presence in Korea with the PORT BOW and COMBAT FOX deployment of Boeing B-52s and numerous tactical aircraft for potential operations (including nuclear) against North Korea and the People's Republic of China.

Robert S. Hopkins

See also

Ferrets; *Liberty,* USS

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The Polish air force was one of the most modern in Europe in the early 1930s, when the PZL series of fighters became operational. Unfortunately, they were still in service and obsolete when Germany attacked on 1 September 1939. (Walter J. Boyne)

PZL Aircraft (Panstwowe Zaklady Lotnicze)

Polish aircraft manufacturer; founded in 1928 as the Polish National Aircraft Establishment, it was chartered to manufacture both airframes and engines. Its airframes were PZL-designed, but most of its engines were license-built Bristol designs. Several PZL (Polish Skoda) engine designs were run, but it is not known that any were put into production.

The chief designer of PZL airframes, Zygmunt Pulawski, produced a series of fighters from 1929 to 1936 that were world-class in their early years, partly because they were high-wing monoplanes when much of the world's air forces still used biplanes. Designated P.1 through P.24—the P.1 being the first fighter of indigenous Polish design—they featured gull wings and all-metal construction. The P.24 was the first with an enclosed cockpit. Pulawski continued to refine the aerodynamics of his aircraft, but these fixed-gear fighters were not competitive with the new generation of German fighters they faced in 1939.

The P.1 first flew on 29 September 1929, the P.6 in August 1930, the P.7 in October 1930, the P.11 in August 1931, and the P.24 in May 1933. The P.24F had a 297 mph maximum speed at 13,945 feet and was the last of the series.

The differences between them were minor except that each made use of the most powerful engine then available, the largest being the Gnome-Rhone 14N 07 of 970 shp. Armament was two small-bore machine guns throughout production until the P.24, which added two 20mm cannons in the wings. The P.7 was still in service with the Polish air force when the Germans invaded in 1939. Other users were the Romanian (license-built by IAR), Albanian, Bulgarian, Greek, and Turkish air forces. Total production of the fighter series comprised approximately 500, about 200 for foreign customers.

The P.38 Wilk, a twin-engine low-wing two-place multi-role fighter powered by inverted air-cooled V-8 engines of PZL manufacture, first flew in May 1938 with the Ranger

SGV-770B engine and in January 1939 with the intended PZL engines. Maximum speed was 289 mph.

PZL built several advanced prototypes, including the P.43, a single-engine low-wing all-metal three-place reconnaissance and attack fixed-gear monoplane; the P.27, a twin-engine midwing all-metal three-place bomber; and the P.44, a twin-engine low-wing all-metal 14-passenger transport with a twin-fin tail, designed to replace the DC-2 and Lockheed 10 and 14 airliners in Polish service.

Douglas G. Culy

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Q

Quesada, Elwood R. (1904–1993)

Aviation pioneer; USAF lieutenant general. Born in Washington, D.C., in 1904, Quesada's military career spanned aviation history from post–World War I biplanes to supersonic jets.

Quesada started his military career during a period of intense experiment and development in aviation, entering the Army Air Service as a flying cadet in 1924. Having only a reserve commission, he returned to civilian life, playing baseball for the St. Louis Cardinals. In 1927, he returned to active service, reporting to Bolling AFB, where he joined Major Carl "Tooey" Spaatz and Captain Ira Eaker in developing air-to-air refueling techniques.

In the years before World War II, Quesada concentrated on the tactical application of airpower and became one of the prime developers of the concept of close air support. When the war started, he got an opportunity to put his ideas to work. In December 1942, he was promoted to brigadier general and sent to North Africa to command the XII Fighter Command. The techniques that he perfected there were incorporated into *Command and Employment of Air Power,* Army Air Forces field regulations published in July 1943.

In October 1943, Quesada went to England to assume command of IX Fighter Command in preparation for the Normandy invasion. During this period, Quesada pioneered many of the techniques that mark modern air-ground cooperation. He placed forward air observers with divisions on the ground where they could call for and control close air support. He mounted radios in tanks so ground commanders could contact pilots directly. He developed the use of radar to vector planes during attacks, which was particularly critical during the Battle of the Bulge in December 1944 when bad weather hid many German targets.

After the war, Quesada was the first commander of the Tactical Air Command. He moved the headquarters from Tampa, Florida, to Langley AFB, Virginia, so he could be close to the headquarters of the Army Ground Forces.

Lieutenant General Quesada retired from the Air Force in 1951. He served as the first head of the Federal Aviation Administration and held numerous positions in several private firms. Quesada died in Washington in 1993.

James H. Willbanks

See also

Close Air Support; Tactical Air Command

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Question Mark

Pioneering aerial-refueling aircraft. *Question Mark* was not the first aircraft to be refueled in midair, as the U.S. Army Air Service first demonstrated inflight refueling as early as 1923. However, the much-publicized flight of *Question Mark,* beginning on New Year's Day 1929, demonstrated aerial refueling's tremendous military potential and galvanized interest in this new airpower role.

This Fokker C-2A trimotor monoplane took its name from the large white question marks painted on the fuselage, as well as the underlying question of how long it could remain airborne. Its crew of five included future Air Force leaders Carl Spaatz, Ira Eaker, and Elwood Quesada. After taking off from Van Nuys, California, *Question Mark* flew continuously for 150 hours and 40 minutes until a faltering engine forced it to land on 7 January. During this historic mission, 43 tanker sorties delivered 5,660 gallons of fuel, plus oil and supplies, to *Question Mark.*

Paul G. Gillespie

The flight of the Question Mark *demonstrated that aerial refueling would be important in the future, but it did not come into extensive use until well after World War II. (U.S. Air Force)*

See also

Aerial Refueling; Eaker, Ira C.; Quesada, Elwood R.; Spaatz, Carl Andrew

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R

Rabaul

Captured on 23 January 1942, becoming the cornerstone of Japan's position in the Southwest Pacific. The action allied one of the best natural harbors in the region with a complex of four major and one minor airfields, supporting 200–300 aircraft and heavy antiaircraft defenses. After Guadalcanal fell to the Allies, Rabaul's importance increased. Allied planners, however, determined to neutralize the base through aerial bombardment.

General George C. Kenney's Fifth Air Force opened the offensive on 12 October 1943. The first attack, by 349 aircraft, was the precursor of a series of raids through 2 November that wrecked many installations, causing the Japanese to excavate replacement underground facilities. The offensive also led Admiral Koga Minechi to reinforce Rabaul with the Combined Fleet's air groups (175 aircraft), which arrived 1 November, and Vice Admiral Kurita Takeo's heavy cruiser force.

Koga's reinforcement prompted a swift reaction. Rear Admiral Frederick C. Sherman's Task Force 38 (*Saratoga* and *Princeton*) struck Rabaul on 5 November, heavily damaging four heavy and two light cruisers. Task Force 38, joined by Pacific Fleet carriers *Essex, Bunker Hill,* and *Independence,* attacked again on 11 November, damaging most remaining warships. The carriers beat back a Japanese counterattack, inflicting such losses that Koga withdrew his battered carrier air groups from Rabaul.

Air Solomons Command, almost 500 aircraft, constructed new airstrips at Torokina on Bougainville, 210 miles from Rabaul, initially supporting only fighters. Fighters swept over Rabaul on 17 December; heavier raids followed through 28 December, but the Japanese made good their losses. Allied attacks recommenced on 5 January, more effectively once Torokina accommodated bombers from 21 January. Two light and one medium or heavy bomber missions struck Rabaul almost daily, accompanied by strong fighter escorts. Fighter opposition remained strong. Reinforcements were flown in from Truk, but attrition took its toll. Few replacements arrived after 1 February, and surface vessels were barred from the area.

The tempo of Allied operations intensified in February. Close to 3,000 sorties were flown over Rabaul to 19 February, almost equaling the total between October and January. A major assault that day, with almost 200 aircraft in two waves, devastated the harbor and airfields and destroyed a quarter of the defending interceptors. Coming two days after the Pacific Fleet struck Truk, it induced the Japanese to withdraw their remaining serviceable fighters. Unescorted Allied bombers assailed Rabaul daily to 15 May, dropping 7,410 tons of bombs on the town and harbor, airfields, and supply dumps. Rabaul was neutralized, despite its garrison of 100,000 troops.

Paul E. Fontenoy

See also

Bismarck Sea, Air Battle of; Boyington, Gregory; Cactus Air Force; Kenney, George C.

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Radar and How It Works

Originally, the acronym for "radio detecting and ranging." Radar equipment was developed to a high level of performance during World War II for the detection of enemy aircraft and surface vessels. It was of crucial importance during the Battle of Britain and, subsequently, in the Combined Bomber Offensive against Germany. The Allies generally were able to stay ahead of the Axis nations, particularly in the Pacific, where United States radar equipment completely surpassed that of the Japanese.

Immediately after the war, radar became widely used in commercial applications, including monitoring weather and controlling air traffic. Early radar systems were heavy and cumbersome and included many separate units. Today, radar units use solid-state devices and microelectronics in compact systems.

Radar systems operate on the echo principle: High-energy radio waves in pulse form are directed in a beam toward a reflecting target. The beam of pulses is like a stream of bullets from a machine gun, with a relatively long space between each pulse of energy. When a pulse of energy strikes a target, which may be a mountain, rain clouds, or an airplane, a portion of the pulse is reflected back to the receiving section of the radar system. A portion of the pulse is reflected and returns toward the airplane. When the reflected pulse reaches the airplane, a second, smaller "pip" appears on the radar screen. The time between the two pips indicates the distance from the airplane to the target. The time between the two pips is shown as microseconds, which represents distance. A typical radar signal may consist of a carrier wave of 8,000 megahertz (MHz) broken into pulses with a duration of 1 microsecond and spaced at intervals of 1/400 second or 2,500 microseconds. This yields a ratio of roughly 2,500:1 for the time of no signal to the time of signal. The ratio of the length of a pulse to the time of no signal varies considerably with the frequency, which ranges from 1,000 to 26,500 MHz.

The length of the pulses of a radar signal may vary from 0.25 to 50 microseconds, depending on the requirements of the system. The pulse repetition frequency also varies according to the distance over which the signals must travel. For very long distances, the pulse rate must be slow enough so that the return signal will be received before another pulse is transmitted. If this were not accomplished, it would be difficult to tell whether the pulse shown on the viewing screen (CRT) was the one transmitted or the one received. The use of the pulse system in radar makes it possible to transmit very powerful pulses. In effect, all the power is concentrated in the very short bursts. If the average power output of a transmitter is 10 watts, the pulse power may be as high as 25,000 watts.

In early types of radar systems, the display on the CRT was a horizontal scale and was called an "A scan." The time between the transmitted pulse and the received pulse indicated the distance of the target from the transmitter. With this type of scan, the direction of the target could not be determined except by noting the direction in which the antenna was pointed. To enable the radar to provide direction information, the P scan was developed. This type of radarscope is also called "plan position indicator" (PPI), since it indicates both the distance and direction (azimuth) of the target. On the face of the PPI, the time-trace starts at the same time that a pulse is transmitted from the radar antenna, and the reflected pulses cause bright spots along the trace line. The trace line is adjusted so that its intensity is very light or almost invisible except at the point where a target signal is received. The pulses are generated at such a frequency that the trace lines scan the entire face of the scope as the antenna makes a complete revolution; hence, as reflected signals appear on the screen, a picture appears in shape similar to that of the object that reflects the signal. The fluorescent coating inside the face of the CRT is of a type that retains a fluorescent glow for several seconds after being activated by the electron beam. Thus, the picture remains on the screen and is reactivated each time that the time trace makes a complete circle.

Albert Atkins

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Radar, and the Battle of Britain

In Britain late 1934, a government committee under Sir Henry Tizzard asked Robert Watson-Watt, a scientist at the National Physical Laboratory, to conduct experiments on the use of radiated radio waves in the detection of aircraft. In reply, Watson-Watt expressed the possibility of using radio telecommunications for intercepting enemy aircraft.

By 1936, future Air Chief Marshal Sir Hugh Dowding met and conferred with Watson-Watt about the possibilities and advantages of using radio detection in the event of war. Dowding, impressed with the scientist's views, gave it his full support. When Henry Tizzard gave the approval to Watson-Watt, the government proposed expenditure on the construction of four radio detection stations. This was further extended to include the construction of 20 stations around the eastern and southern coasts by August 1937. The range of these stations, located at 20-mile intervals, was 83 miles (132 km) and a height of 13,000 feet (3,939 m); 50 miles (80 km) 5,000 feet (1,515 m); 35 miles (56 km) 2,000 feet (606 m); and 25 miles (40 km) 1,000 feet (303 m), respectively. The masts of these stations were no less than 50 feet (15 m) above sea level and had a minimum height of 200 feet (60 m).

The radio stations, called Chain Home, did have one big disadvantage: Detection of aircraft below 5,000 feet was unreliable. To solve this, the more complicated Chain Home Low was installed. Using a frequency of 200 megahertz (MHz), a power output of only 150 kilowatts, and with a range of only 50 miles (80 km), it could only read straight ahead. But it covered the gap between the lower edge of the Chain Home beam and the surface of the sea, allowing the system to detect aircraft crossing the English Channel at low levels.

With no point more than 20 minutes from the coast, Britain's biggest problem was detecting enemy planes in time to intercept them. Radar enabled the RAF to stay on the ground until the Luftwaffe was known to be approaching, thereby offsetting to some extent the numerical superiority of the enemy.

British planes were first equipped with radar sets of limited range in 1939. In July 1940, a radar-equipped plane shot down the first enemy plane. In August of that year, the RAF began to receive its first Beaufighters equipped with improved radar sets, a combination that was to prove highly effective.

The use of radar by the British provided enough of an edge to meet the Luftwaffe threat and postpone the planned Nazi invasion of Great Britain.

Andy Blackburn

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Rall, Guenther (1918–)

The third-highest scoring fighter pilot of all time. Rall joined the German army in 1936 and transferred to the Luftwaffe in 1938. He was assigned to Jagdgeschwader 52 (JG 52; 52d Fighter Wing) in August 1939 and remained in this most successful of all fighter units for the next four years. He scored steadily against the Red Air Force, received the Oak Leaves with Swords to the Knight's Cross of the Iron Cross, and on 28 November 1943, became the second Luftwaffe pilot after Walter Nowotny to claim 250 victories.

On 19 April 1944, Rall was summoned to Germany to take command of the 2d Gruppe (Group) of JG 11, a fighter unit in the Reichsluftverteidigung (Air Defense of Germany). Like many pilots who transferred from the Eastern Front, Rall quickly became a casualty—on 12 May 1944, after scoring his 275th and last victory, he was shot down by a P-47 and lost a thumb. After his hospital stay he was given a school posting and then, in February 1945, took command of JG 300, another Reichsluftverteidigung fighter wing. However, the fuel shortage and chaos accompanying the war's final days prevented Rall from achieving any success with his new command.

Rall joined the Bundesluftwaffe, West Germany's postwar air force, in 1956 and rose to command it from 1970 to 1974. His final rank was major general.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Raskova (née Malinina), Marina Mikhaylovna (1912–1943)

Soviet major; commanding officer of the 587th Dive-Bomber Regiment (renamed 125th "M.M. Raskova" *Borisov* Guards Dive-Bomber Regiment). She formed three women's combat wings in Engels, near Stalingrad, in 1941–1942. Earlier, she was a navigator of an ANT-37 named *Rodina* (Homeland)—pilot Valentina Grizodubova, copilot Polina Osipenko—on a pioneering nonstop flight from Moscow to the Pacific (6,450 kilometers) on 24–25 September 1938. Raskova was awarded the Hero of the Soviet Union for this feat, becoming one of the first three Soviet women to be thus honoured.

She acquired specialized knowledge of navigation while employed at the Zhukovsky Air Force Engineering Academy. Raskova was the first Soviet woman to earn the diploma of professional air navigator and became an instructor at the academy. She received flight training at the academy's expense.

A senior navigator in Moscow's May Day air shows, she participated in important flights from 1935, including the *Rodina* flight. On this occasion, her pilot—short of fuel—had no choice but to land immediately. Fearful of nosing over, he ordered Raskova, who was positioned in the forward cabin, to bail out. As a result, she spent 10 days wandering in the taiga, a difficult ordeal to survive.

When Raskova's bold proposal to form a women's air group was finally accepted in 1941, she was faced with the difficulty of transforming civilians into disciplined military personnel. After she died in a crash during a heavy snowstorm on 4 January 1943, her subordinates pledged to become worthy of bearing her name and qualify as Guards regiment, which they did in 1943. In the same spirit, her No. 2 Squadron's tactics, as applied in the air battle of 4 June 1943, became a model for Soviet bomber aviation.

A pupil of famous navigators A. Belyakov and I. Spirin, she cultivated the best qualities in everyone. Raskova was a talented organizer and a bold dreamer, with a personality that endeared her to subordinates. This was the key to her success. Her ashes were placed in the Kremlin Wall beside those of Osipenko.

Kazimiera J. Cottam

See also

Grizodubova, Valentina; Soviet Women's Combat Wings

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Ravens (1966–1974)

Experienced volunteer USAF forward air controllers (FACs) during the Vietnam War; served directly with the armed services of Laos to stop invading North Vietnamese forces. These FACs were initially introduced in mid-1966 under a program called "Steve Canyon." This was part of Project 404, a Joint Chiefs of Staff–directed initiative to covertly assign U.S. military personnel to Laos. Flying out of austere forward airfields in small O-1, U-17, and T-28 aircraft, the Ravens directed U.S. Air Force, Navy, Marine, and allied aerial forces in direct support of Laotian ground units and to interdict North Vietnamese supply columns. With the end of hostilities in February 1973, the Ravens were transferred to Udorn Air Base in northern Thailand. There, they trained FACs for the Royal Cambodian Air Force until deactivated in 1974. Less than 200 USAF officers served as Ravens. Thirty-one were killed in the conflict, and none were ever listed as prisoners or released by the North Vietnamese or Laotian communists at the end of the conflict.

Darrel Whitcomb

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Read, Albert C. (1887–1967)

U.S. Navy rear admiral. Born on 28 March 1887 in Lyme, New Hampshire, Read graduated from the U.S. Naval Academy in 1906. He served at sea until 1913, at the Naval Torpedo Station for two years, and then completed flight training in 1916. After further sea service, he commanded naval air stations in the eastern United States during World War I.

Lieutenant Commander Read in March 1919 assumed command of the flying boat NC-4, one of four aircraft selected to undertake a transatlantic flight led by Commander John H. Towers. In the event, NC-4 and its crew completed the first aerial transatlantic crossing (17–27 May) from Trepassey Bay, Newfoundland, to Lisbon, with a stop in the Azores.

Between 1920 and 1929, Read commanded various naval air squadrons and stations and attended the Naval War College. He then served at the Bureau of Aeronautics until 1938, with a two-year stint commanding USS *Wright,* before returning to sea as captain of the carrier *Saratoga* until 1940. Read, promoted rear admiral in 1941, next commanded Naval Air Station Pensacola until 1942, when he became chief of air technical training. His final assignments were as commander, Fleet Air, Atlantic Fleet, 1944–1945, and in the office of the deputy Chief of Naval Operations (Air) until September 1946, when he retired. Read died in Miami, Florida, on 10 October 1967.

Paul E. Fontenoy

See also

Curtiss Aircraft; Towers, John H.

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Reber, Samuel (1864–1933)

U.S. Army colonel. Born in St. Louis, Missouri, Reber was the grandnephew of General William T. Sherman. He belonged to the West Point class of 1886 that also included John J. Pershing, Mason M. Patrick, and Charles T. Menoher. Upon graduation, Reber joined the cavalry. After studying electrical engineering at Johns Hopkins University, Reber transferred to the Signal Corps in 1894. During the Spanish-American War, he served in Puerto Rico under General Nelson A. Miles. In 1900, he married Miles's daughter, Cecelia.

Reber, an accomplished balloonist, was among those Army officers who early on recognized aviation's military potential. He became head of the Signal Corps's Aeronautical Division in 1913 and a year later became the first chief of the new Aviation Section. He subsequently expressed to Congress his concerns regarding the nation's unpreparedness for aerial combat and the lack of reliable information about events overseas. Reber and Chief Signal Officer George P. Scriven served as the Army's initial representatives to the National Advisory Committee for Aeronautics formed in 1915.

A highly intelligent and energetic officer, Reber's promising career was cut short amid controversy. In 1914, the inspector general had issued an unfavorable report about conditions at the Signal Corps Aviation School in San Diego, successor to the original facility at College Park, Maryland. Accidents were frequent and often fatal, and a serious rift had developed between aviators and their administrators.

For reasons unknown, Reber suppressed the report and failed to fully implement its recommendations to improve safety. The Signal Corps replaced pusher planes with tractors, but the underlying institutional problems remained. The situation at San Diego fed the growing sentiment to withdraw aviation from the Signal Corps. Secretary of War Newton D. Baker censured both Scriven and Reber. After further investigation, Baker removed Reber as chief of the Aviation Section in May 1916. Although Reber remained in uniform until 1919, his official aviation duties had ended.

After retirement, Reber enjoyed a successful second career with the Radio Corporation of America. He is buried in the Miles family mausoleum at Arlington National Cemetery.

Rebecca Robbins Raines

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Reeves, Joseph M. (1872–1948)

U.S. Navy admiral; the father of carrier warfare. Joseph Mason Reeves was born in Tampico, Illinois, on 20 November 1872. After graduating from the U.S. Naval Academy, Reeves was commissioned as an assistant Engineer in the Engineering Corps. In 1898, Reeves won commendations for his performance on the USS *Oregon* during its epic voyage around Cape Horn and spectacular performance at the Battle of Santiago (Spanish-American War). After transferring to the line in 1899, Reeves became one of the leading gunnery officers in the Navy.

In 1913, Reeves was ordered to duty in command of USS *Jupiter,* the first turboelectric-powered ship in the Navy. When Reeves returned to the ship in 1925 as commander, Aircraft Squadrons, Battle Fleet, *Jupiter* had been transformed into the Navy's first aircraft carrier and renamed USS *Langley.* During the next four years, Reeves transformed the Navy's nascent air force from a small auxiliary command whose primary mission was to support the battle force into a powerful strike force that could attack inland or far at sea in advance of the battle line.

Admiral Reeves was the first qualified aviation officer in the U.S. Navy to achieve flag rank. He was the first to bear the title "carrier commander" and holds the distinction of being the first aviation officer in the Navy to serve as commander in chief, United States Fleet.

Thomas Wildenberg

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Regia Aeronautica (Pre–World War II)

The Regia Aeronautica (Royal Air Force, RA) was created on 28 March 1923, merging the Italian army and navy air services to fulfill fliers' aspirations for independence. Nominally comprising all the military air forces of the kingdom and of its colonies, the RA consisted in fact of the Armata Aerea (Armera, the air army tasked with air war missions, including air defense); and the Aviazione per il Regio Esercito and Aviazione per la Regia Marina (Esercitavia and Marinavia, respectively the army and navy auxiliary air services)—the last two under the operational control of the army and navy, which also issued technical specifications. The basic air unit was the *squadriglia* (squadron, normally nine aircraft under a captain); the largest were the territorial air zones (ZATs) and commands (e.g., the Aeronautica dell'Egeo). In wartime, each ZAT generated a *squadra aerea* (air force) comprising divisions and brigades, which in turn controlled *stormi* (wings).

The RA reported to the Commissariat for Aeronautics, formed on 24 January 1923 and upgraded to Air Ministry on 30 August 1925, which controlled all aeronautical activities, including procurement, research and development, and civil aviation. From 1923 to 1929, the post of high commissar/minister was held by Benito Mussolini, whose multiple other positions ensured that aviation was run by the deputy commissars and undersecretaries like Aldo Finzi (1923–1924), General Alberto Bonzani (1924–1926), and Italo Balbo (1926–1929). Balbo became minister in 1929, but Mussolini returned to the position from 1933 to 1943 and called on Chief of Staff General Giuseppe Valle to double as undersecretary (1933–1939). Compounded by his lack of an independent power base, this created a damaging short-circuit between policy, procurement, and operations.

The new unified organization was symbolized by the Air Ministry building, inaugurated in 1931 to bring together offices dispersed in 12 locations; between 1926 and 1932 airfields grew from 105 to 180, and a comprehensive test center was built at Guidonia, near Rome. Few regular and virtually no senior officers transferred to the RA, so leadership was another challenge. The Air Academy was formed in 1923, followed by the Air War School in 1934, but up to World War II many generals were former air observers or came from the airship branch (disbanded in 1928); units remained staffed largely by NCO and short-term commissioned pilots.

Aviation pioneer Giulio Douhet never held any RA position, and his command-of-the-air doctrine was more a justification for independence than a blueprint for expansion; indeed, his outspoken critic Amedeo Mecozzi was allowed to organize a fighter-bomber "assault brigade," crippled only by inadequate aircraft. Both agreed on the use of poison gas and discounted targeting and intelligence. The large exercises held in 1927 and 1931 helped bridge the gap between theory and practice, but the RA developed as a tactical force geared to army and navy needs: Although the 1937–1939 expansion plan called for up to 1,043 bombers, the strategic component never exceeded 12 aircraft.

Considerable efforts were channeled into propaganda to increase domestic air-mindedness but also to display the progress made by Italy under Mussolini. The RA successfully vied for world records for speed, altitude, distance, and endurance, and in 1939 it still held one-fourth of all records recognized by the International Aeronautical Federation. Aircraft exports and aeronautical missions in countries ranging from the Soviet Union to China became valuable foreign-policy tools. German aircrews were trained secretly during 1933–1934.

Fascist rhetoric and some historians link aviation and the regime, but actually the RA remained the junior service. More important, its modest budget (roughly 15 percent of all Italian military expenditures) had to provide for both the Esercitavia and Marinavia. Because it threatened to circumvent RA independence, this arrangement created interservice tension, and the air force fought successfully to gradually reduce its external commitments; in return, it undertook to make Armera assets available when necessary. The RA kept its word in Ethiopia and Spain, emerging with great prestige as a modern, if not advanced, air force. Its crews had gained considerable combat experience, partially offsetting their inadequate training. Unfortunately, the prolonged war effort delayed the much-needed renewal of front-line aircraft, and on the eve of World War II the RA was on the verge of obsolescence.

Gregory Alegi

See also

Balbo, Italo; Ethiopian War; Italian Aircraft Development; Regia Aeronautica (World War II); Spanish Civil War

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Regia Aeronautica (World War II)

Interwar and World War II Italian air force, created on 28 March 1923 by merging the Italian army and navy air services to fulfill fliers' aspirations for independence. When the Nazis invaded Poland, Italian dictator Benito Mussolini committed Italy to "nonbelligerence"; on 31 October 1939, he appointed General Francesco Pricolo (1891–1980) as undersecretary and Chief of Staff. Pricolo set out to rebuild the Regia Aeronautica (RA), drained by its efforts in Ethiopia and Spain. Believing that the design competitions of 1938–1939 would soon produce modern types, he began by eliminating obsolete aircraft. But Mussolini, fearing that a victorious Hitler would dictate the future of Europe, rushed Italy into war to gain a seat at the peace table. This led to the paradox of the so-called parallel war, in which Italy competed with its German ally rather than combine forces.

On 10 June 1940, the RA had 84,000 men and 1,795 operational aircraft (3,300 total), distributed among 23 landplane and two seaplane bomber wings, the equivalent of 10 fighter wings, an "assault" wing, and two heavy fighter groups. These reported to three *squadre aeree* (air forces), raised to five by the end of the year, and four geographical commands (Sardinia, Albania, the Aegean, and East Africa); in addition, large auxiliary air services came under direct army and navy control.

An operational HQ—Superaereo—was formed, but air assets came under theater commanders—invariably army generals, who also dominated the Supreme Command. The resulting ignorance of airpower translated in the lack of an air campaign against strategic targets such as Malta; instead, medium bombers were employed against unsuitable tactical targets like French forts in the Alps or Greek strongpoints on the Epirus. This fundamental misconception was compounded by internal shortcomings. Training, still patterned upon World War I practice, was inadequate. Pilots reached operational units with 150 hours experience, gained in more than a year, with much emphasis on aerobatics and formation flying but little on navigation, gunnery, and tactics. Operational training and, at first, conversion, occurred largely in combat units, increasing losses among newly assigned aircrews. The limited industrial resources were severely mismanaged, with political influence allowing dominating manufacturers to continue producing obsolete aircraft like the Fiat CR.42. Furthermore, while the RA sought to improve performance by introducing new types rather than developing existing ones, its blend of perfectionism and design interference delayed until 1943 the service entry of designs already flying in 1939, like the Cant Z.1018. As a result, up to September 1943 Italy built 11,500 aircraft, supplemented by 400 received from Germany and 97 French war prizes.

These considerations largely explain why the RA could not win the war as prophesied by Giulio Douhet. Still the RA fought bravely on every front, with some tactical success, and the fragmentary evidence available confirms that it did not shirk. In 1940–1945, the RA flew some 280,000 sorties for 560,000 hours, claiming 2,533 air-to-air victories plus 474 aircraft destroyed on the ground, and 144 pilots were credited with five or more kills; aggregate losses to all causes came to 6,805 aircraft and 22,805 personnel (including 25 percent aircrews).

An unremarkable campaign was flown against France just before its surrender to Germany. The next theater was East Africa, so isolated from Italy that its fate was sealed from the beginning. After unsuccessful attacks on Aden, the RA conducted tactical operations until resistance ended on 27 November 1941. From October 1940 to January 1941, the RA also participated in the Battle of Britain with two bomber wings and a fighter wing. Because of limited navigation skills, different radios, and language problems, operations with the Luftwaffe proved difficult and little was achieved. On 28 October 1940, Italy attacked Greece and the RA was called to provide ground support against bitter resistance. In April 1941, the war extended to Yugoslavia, where rugged army observation biplanes, lacking aerial opposition, were used effectively against partisans in an unsung campaign that dragged on until the Italian armistice. The harsh winters were the chief enemy of the fighter group and the observation group deployed to Russia in 1941–1943.

North Africa was the main RA theater of war, and the local 5th Squadra received the best units and equipment. Unfortunately, they were used mostly to counter mobile British land units and compensate for army immobility. The arrival of modern aircraft, including Macchi fighters and Stuka dive-bombers, allowed temporary air superiority, and large-scale fighter sweeps confirmed the principle of mass, but they remained very rare. In the interior, the colonial air units created before the war against Libyan rebels proved equally adept against British intruders.

Postwar navy literature makes much of the alleged RA veto on carrier construction, but actually the RA played a crucial role in the Mediterranean, showing both limitations and virtues. When hundreds of medium bombers attacked British ships at Punta Stilo (8–15 July 1940), their light bombs proved inaccurate and ineffective. Pricolo reacted swiftly, and already on 15 August the first S.79 torpedo-bombers struck ships in Alexandria Harbor. The new branch expanded rapidly, peaking in 1943 at 12 groups and three operational training units, staffed by combat veterans. Their hard-won successes included 18 warships (including eight cruisers and a battleship) sunk or requiring up to 48 months to repair; their own losses were correspondingly heavy. Significant air assets were also absorbed by convoy escorts and maritime reconnaissance. Malta was the subject of constant attacks, most effective when carried out with the Luftwaffe. Unfortunately, the German X Fliegerkorps was withdrawn in summer 1942 when the island was about to capitulate.

Pricolo was relieved on 15 November 1941, ostensibly for having postponed dispatching to Libya the first Macchi C.202 wing but also because of clashes with the Supreme Command. His replacement was the pragmatic General Rino Corso Fougier (1894–1963), a World War I ace who put into production the Macchi C.205 against considerable Fiat resistance. In November 1942, the Axis defeat at El Alamein triggered the final African retreat, which ended with the fall of Tunisia in May 1943. For six months, the army was supplied and evacuated largely by air. Initially formed by requisitioned airliners, the Comando Servizi Aerei Speciali (Special Air Services Command, CSAS) grew to comprise numerous wings. In the face of grievous losses, CSAS performed sterling work and peaked at 100 sorties per day.

When the Allies used North Africa to launch an air campaign against Italian cities, the RA proved inadequate. Daylight fighters were largely obsolete and night-fighters were in their infancy; there was neither centralized fighter control nor coordination with antiaircraft artillery, which was an army responsibility; attacks on airfields and factories compromised mobility and depleted resources. Although its personnel had grown to 180,000, by summer 1943 the RA fielded only 400 combat aircraft. The loss of Sicily and the U.S. bombing of Rome (19 July 1943) signaled defeat.

On 25 July, the fascist Grand Council voted against the dictator, allowing the king to name Marshal Pietro Badoglio prime minister. Badoglio appointed General Pietro Sandalli air minister and negotiated with the Allies the armistice that was announced on 8 September 1943. The king and military leadership repaired to Brindisi, in the south, leaving the country in chaos. The Germans interned more than 600,000 men and killed thousands who resisted. On 13 October 1943, Italy declared war against Germany and was recognized as "cobelligerent" by the Allies. Reduced to 20,000 personnel and less than 500 aircraft, the RA became part of the Balkan Air Force. Fighters were assigned tactical roles, and bombers dropped supplies to Italian troops and partisans in Yugoslavia; air/sea rescue (occasionally behind German lines), target-towing, and other support duties were carried out for the Allies. With Allied mistrust finally overcome, limited quantities of P-39s, Spitfire Vs, and Baltimores arrived in June 1944; simultaneously, Sandalli was replaced by General Pietro Piacentini, succeeded by political undersecretaries after only six months. Despite the difficulties generated by conflicting U.S. and British perspectives for the Mediterranean, RA activities during 1943–1945 helped lay the foundation for a postwar recovery in the Western camp.

Gregory Alegi

See also

Aeronautica Nazionale Repubblicana; Britain, Battle of; CRUSADER; Greece; HUSKY; Italian Aircraft Development; Italian Campaign; Mareth Line; Mediterranean Theater of Operations; North African Campaign; Pantelleria; PEDESTAL; Regia Aeronautica (Pre–World War II); Salerno, Battle of; Somalia; Taranto Air Attack; TORCH; Ultra

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Reitsch, Hanna (1912–1979)

The most celebrated female aviator of Nazi Germany. She won world fame as a glider pilot before the war. Reitsch worked as a test pilot for the Luftwaffe, performing demonstrations for Charles Lindbergh and making a famous indoor flight of the Focke autogiro/helicopter in 1938. An ardent Nazi, she was the second woman recipient of the Iron Cross Second Class, being decorated by Hitler personally in 1941. She was the only woman to win the Iron Cross First Class, after being injured testing the Messerschmitt 163 rocket fighter in 1942. Her most legendary flight was landing a damaged Fieseler Storch near the Brandenburg Gate at the height of the Battle of Berlin (April 1945). Ordered by Hitler to leave the Führerbunker before the Russians assaulted it, she took off from the Tiergarten in central Berlin between artillery barrages. Her flight fed rumors of Hitler's possible escape. Jailed by the Allies for more than a year, she continued competitive gliding after the war.

Christopher Simer

See also

Fieseler Fi 156 Storch

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Republic Aircraft

U.S. aircraft manufacturer. In 1935, the USAAC began a series of design competitions in order to obtain an advanced monoplane fighter. The Seversky Aircraft Corporation won the competition and received an order for 77 examples, designated the P-35. In 1939, Founder Alexander Seversky then lost control of the company, which changed its name to Republic Aviation.

Republic produced an export version of the P-35 that had a more powerful engine and two additional machine guns. One hundred twenty of these were sold to Sweden, but 60 were subsequently diverted to U.S. stocks and served in the Philippine Islands.

After Republic had finished the production run of the P-35A, it set out to develop a more advanced version. Two different projects resulted—the XP-41 and the P-43. Both had more powerful engines than the P-35A, as well as a redesigned airframe, but retained the characteristic wing shape that was designer Alexander Kartveli's signature note. Testing of these prototypes resulted in a USAAC service test contract for 13 YP-43s in March 1939, followed by production orders for 54 P-43s, 80 P-43As, and 125 P-43A-1 fighters for China.

The next Republic aircraft to reach production was the P-47 Thunderbolt. While the first P-47B was testing, Republic was hard at work at getting production under way in the new plant building just completed at Farmingdale on Long Island, New York. In addition to this, the first of three new paved runways was completed. Ultimately, expansion of this facility would quadruple the size of the factory floorspace. Even so, all this new construction was inadequate to meet the future contract demands for the Thunderbolt.

In November 1942, the War Production Board authorized a new plant to be constructed adjacent to the Evansville, Indiana, airport. This would provide the critical production volume that would enable the P-47 to become the most-produced U.S. fighter of World War II. Production would ramp up slowly, largely a result of the extensive testing involved.

The F-105 was the first aircraft developed specifically as a single-seat Mach 2 nuclear fighter-bomber and gained its fame in the skies over Southeast Asia. (Walter J. Boyne)

In the post–World War II period, Republic resumed production of attack aircraft, including the F-84 and F-105. It attempted to build civilian aircraft (the Seabee amphibian) but was not successful. It was purchased by Fairchild Hiller in 1965 and became Fairchild Republic in 1971, building the A-10 Warthog.

Albert Atkins

See also

Fairchild A-10 Thunderbolt II; Republic F-105 Thunderchief Republic F-84 Thunderjet/Thunderstreak; Republic P-47 Thunderbolt; Seversky Aircraft

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Republic F-105 Thunderchief

The first aircraft developed specifically as a single-seat Mach 2 nuclear fighter-bomber. Alexander Kartveli began designing the aircraft in 1952, and the first flight of the YF-105A was made on 22 October 1955. The results were disappointing—the aircraft was underpowered and had more drag than expected. The incorporation of the area-rule principle and a new Pratt and Whitney J75 engine solved these problems, and 78 F-105Bs were produced. Their MA-8 fire-control system never lived up to expectations, and the aircraft were quickly relegated to Air National Guard and Air Force Reserve service. An improved ASG-19 Thunderstick fire-control system was incorporated into 610 F-105Ds and 143 two-seat F-105Fs produced between 1959 and 1965. The F-105 gained its fame in the skies over Southeast Asia—carrying weapons it was not designed to use in a war it was not supposed to fight. More than 20,000 combat missions were flown by Thunderchiefs in Southeast Asia, resulting in the loss of 336 aircraft. Many F-105Fs were adapted as the first successful Wild Weasel defense suppression aircraft, with 65 being redesignated F-105G. The last Thunderchiefs were retired in 1983.

Dennis R. Jenkins

See also

ROLLING THUNDER; Wild Weasel

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Republic F-84 Thunderjet, Thunderstreak, and Thunderflash

The first jet fighter designed in the United States after World War II; at least three distinctive variants of the Republic F-84 had long careers. The first production F-84s began appearing in June 1947, and 1,414 of these straight-wing Thunderjets were produced.

Republic incorporated a swept wing into the F-84F Thunderstreak, which ran into significant development problems. This led to the production of another straight-wing variant, the F-84G Thunderjet, the first fighter equipped for boom-style aerial refueling and the first Air Force fighter capable of delivering tactical nuclear weapons. Straight-wing F-84s began arriving in Korea during the summer of 1950, scoring their first MiG kill on 21 January 1951. As an air-to-air fighter, however, the F-84 was a disappointment—only nine enemy aircraft were downed for a loss of 18 Thunderjets. Therefore, most of the 86,400 F-84E/G sorties were used to deliver 55,987 tons of bombs.

Production of the F-84G totaled 3,025 aircraft, and 2,236 of these equipped the air forces of Belgium, Denmark, France, Greece, Iran, Italy, the Netherlands, Norway, Portugal, Taiwan, Thailand, Turkey, and Yugoslavia.

Although the swept-wing F-84F had flown as early as November 1952, it was not until January 1954 that production aircraft began to be delivered. By August 1957, however, 1,711 had been built. These swept-wing fighters were so different than the earlier F-84s that it is regrettable that their original F-96 designation was not retained. NATO received 1,301 F-84Fs for Belgium, France, Greece, Italy, and Turkey. The Thunderstreak was also the first modern fighter to equip the West German Bundesluftwaffe.

A reconnaissance variant that moved the air intake from the nose to the wing roots was also produced. These RF-84F Thunderflashes, with 715 built, served with Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, Norway, Turkey, and Nationalist China in addition to the United States. A few special RF-84K FICON (fighter-conveyor) versions were modified to be carried semisubmerged in the bomb bay of GRB-36F bombers.

Dennis R. Jenkins

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Republic P-47 Thunderbolt

The high-altitude Republic P-47 Thunderbolt fighter was the evolutionary culmination of warplanes designed and built by Alexander Seversky. In 1933, Michael Gregor, a Seversky engineer, demonstrated the semielliptical wing planform with high-speed airfoil and metal cantilever construction that would lay the foundation of P-47 performance.

In 1940, when the USAAC required a heavily armed high-altitude fighter, Alexander Kartveli and the Republic firm, the successor to Seversky, offered an aircraft featuring a 2,000-hp radial turbosupercharged engine and armed with eight wing-mounted .50-caliber machine guns.

Based in England, Thunderbolt units went into action in April 1943. In November 1943, P-47s entered the fray in the

The Republic P-47 was beloved by its pilots, many of whom survived combat and accidents solely because of the great strength and power of the Thunderbolt. (U.S. Air Force)

The radical and unsuccessful Northrop XP-56 Black Bullet was one of several exotic responses to the Request for Data R40C. (Walter J. Boyne)

Mediterranean. Thunderbolt formations commenced fighting in the Southwest Pacific in June 1943 and in China by April 1944.

The P-47 was hampered by a poor turn radius, a low rate of climb, and a range that prevented escort of U.S. bombers over Germany. But these aspects were offset by high speed—428 mph at 30,000 feet—rapid roll rate, dive speed, and subsequent zoom climb. A number of German pilots, accustomed to fighting against Spitfires, often made the fatal mistake of diving away from pursuing Thunderbolts. A combat loss rate of less than 0.7 percent testified to the Thunderbolt's exceptionally strong construction. The P-47 also proved to be a devastating fighter-bomber and wrought havoc on enemy ground forces, railroads, and air bases.

Many improvements were incorporated in the P-47. Modified propeller blades greatly increased climb rate. Range was extended through the use of external fuel tanks. A bubble canopy enhanced pilot visibility.

More Thunderbolts, 15,683, were built for the USAAF than any other fighter. Together with the North American P-51, the formidable P-47 won the struggle for control of the skies over Europe in World War II.

Sherwood S. Cordier

See also

Engine Technology; Republic Aircraft; Seversky Aircraft

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Request for Data R-40C: The XP-54, XP-55, and XP-56 Fighter Programs

U.S. Army Air Corps fighter program based on a Request for Data rather than the usual Circular (Request for) Proposal just prior to World War II. In mid-1939, the USAAC realized that U.S. fighter aircraft such as the Lockheed P-38, Bell P-39, and Curtiss P-40 might not be competitive with the Messerschmitt Bf 109 and Supermarine Spitfires already in service. They believed that continued improvement in foreign aircraft would outpace the rate of improvement in the United States. The USAAC's goal was to accelerate the development of faster aircraft (specified: 425 mph, desired: 525 mph). To assist in this, in addition to the 1,250-shp Allison V-1710, two new "Hyper" engines would be available—the 1,700-shp Continental IV-1430 and the 1,850-shp Pratt and Whitney X-1800.

The solicitation by means of a Request for Data deviated from the usual Circular (Request for) Proposal procurement method and specified a three-phase program: 30-day preliminary design data generation, building and testing wind-tunnel models, and design and fabrication of prototypes, with first delivery by 30 June 1941.

Twenty-three proposals were received from seven manufacturers, including two divisions of Curtiss-Wright. These were grouped into three categories: I—those that were mere modifications of existing production designs; II—those advanced designs capable of production by 1942; and III—those designs needing an advanced engine, whether or not the airframe design was advanced.

Three designs were selected from Category II: the Vultee

The Bell X-2 suspended below a Boeing B-50D carrier plane. (Walter J. Boyne)

Model 70-2, the Curtiss Model P-249C, and the Northrop Model N-2B; all were pushers, a configuration selected for higher aerodynamic efficiency. Each was contracted for the first phase of development in June 1940.

The proposed Vultee Model 70-2 had a single seat, single X-1800 engine, twin fuselage booms, twin tail, a 40-foot inverted gull wing, and tricycle landing gear. Changing USAAC requirements and cancellation of the X-1800 engine program resulted in the Model 78 (XP-54) with the Lycoming XH-2470 engine. It first flew in January 1943, 18 months late. Two were built, and maximum speed was 381 mph.

The proposed Curtiss Model P-249C was the result of studies that predated the R40-C invitation by a year and was so radical (a swept-wing with a canard-type free-floating elevator at the nose of the airframe) that after wind-tunnel tests the AAC cancelled the program as being too risky. Curtiss-Wright saw promise in the test results and decided to fund a proof-of-concept demonstrator, the CW24-B, which flew in December 1941. Flight tests validated the concept, and the XP-55 contract was reinstated in July 1942. Initially, three engine alternatives were proposed: the V-1710, the IV-1430, and the Wright R-2160. The IV-1430 was initially selected, but when the XP-55 started construction the IV-1430 and the R-2160 were not ready, so the V-1710 was selected, and the first flight of the XP-55 was in July 1943, two years late. The XP-55 had a maximum speed of 390 mph.

The Northrop N-2 was proposed with four engine alternatives: the R-2800, the X-1800, the V-1710, and the R-1830. The X-1800 had been selected, but cancellation of the X-1800 program resulted in selection of the R-2800 driving counter-rotating propellers. The N-2 (XP-56) was a flying wing with a stubby fuselage and made extensive use of magnesium in the structure and skin. Two were built, with engine and airframe problems delaying the first flight to September 1943, more than two years late. Maximum speed was 340 mph.

Although all three of the R40-C airplanes showed promise, each missed performance goals, further development was required, and it was realized that they would not be available in time to affect the war. Also, by early mid-1944, the promise of the jet fighter was being realized, and the three programs were cancelled in May. The XP-54 had 63 flying hours, the XP-55 had about 60, and the XP-56 had about 15. One each of the XP-55 and XP-56 prototypes crashed during flight-testing, but flight evaluation of these programs continued after cancellation. The two XP-54 prototypes were scrapped shortly after cancellation.

Douglas G. Culy

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Research Aircraft

Vehicles that provide design data for military aircraft and spacecraft. Research aircraft can be any airplane used for flight research, that is, gathering data to better understand some aspect of flight. The primitive airplane the Wrights flew in 1903 at Kitty Hawk was the first research aircraft; its successors have included an enormous variety of airplanes, from gliders and subscale research vehicles to the latest X-plane.

Most people probably think of research aircraft as X-planes, with several dozen having been developed to date. In the United States, this series of research aircraft (as distinguished from prototypes) began in the 1940s to gather data supersonic flight. Pursuit aircraft like the P-38 Lightning were approaching this speed in dives—with often disastrous results. Aerodynamicists lacked accurate wind-tunnel data for the speed range Mach 0.95 to Mach 1.2 until a slotted-throat wind tunnel became available at midcentury. Since then, design and performance of research aircraft have greatly advanced, offering valuable data on atmospheric and space flight.

J. D. Hunley

See also

Bell X-1; Douglas D-558; Lockheed P-38 Lightning; North American X-15; Wright, Orville; Wright, Wilbur

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The famous Red Baron, Captain Manfred Richthofen, seen here with his younger brother, Lothar. He rose quickly through the ranks and was shot down 21 April 1918, nobody can say for sure by whom. (Smithsonian Institution)

Richthofen, Manfred von (1892–1918)

The legendary Red Baron of World War I. Manfred von Richthofen was the eldest son of a Prussian officer. As a boy he attended a military academy where, apart from sports, he was considered average. When World War I began he was with the cavalry. But during the summer of 1914 movement had come to a standstill and the armies dug into the trenches. Bored, Richthofen sought a transfer to aviation.

After duty first as an observer, then as a bomber pilot, Richthofen met and impressed the ranking German ace, Oswald Boelcke, who invited him to join Jasta 2, which was just forming for the Battle of the Somme.

Under Boelcke, Richthofen quickly developed into a deadly tactician. By the time of his mentor's death, his score stood at seven and was rising fast. His sixteenth brought him Prussia's highest award, the Pour le Mérite, and a command of his own Jasta 11.

Painting his Albatros red so his pilots would see him in combat, Richthofen acquired the nickname by which he has been immortalized. Over the next months his legend grew with his scores, awards, ranks, and responsibilities. By early summer he was a *rittmeister* (cavalry captain, a reference to his original unit affiliation) in command of a *jagdge schwader* (fighter wing) with 56 victories when he suffered a head wound. His wound slowed the scoring pace, and his number stood at 63 when the German offensive opened in March 1918.

Regaining his stride, Richthofen drove his victories to 80 by 20 April, the day before his death. On 21 April, he took off flying the red Fokker triplane with which he's perpetually linked. Leading two flights of Jasta 11, his group encountered a similar number of Sopwith Camels from RAF No. 209 Squadron. Richthofen began chasing Lieutenant Wilfred May over the Somme River Valley. May's plight attracted the attention of Captain Roy Brown, who dove after the red triplane. As the trio came over the Morlancourt Ridge, several Australian ground gunners began firing. Richthofen fell, opening the debate "who killed the Red Baron?"—a question that still perplexes World War I aviation historians.

James Streckfuss

See also

Albatros Aircraft; Boelcke, Oswald; Fokker Aircraft (Early Years); German Air Service; Voss, Werner

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Richthofen, Wolfram Freiherr von (1895–1945)

One of the most influential Luftwaffe commanders. Von Richthofen joined the German cavalry in 1913, took flight training in 1917, and was assigned to the fighter unit commanded by his more famous cousin, Manfred (the Red Baron). He left military service after World War I and obtained a doctorate in mechanical engineering before joining the Reichswehr, the interwar army, in 1923. His unique technical education brought him a wide range of assignments in the newly formed Luftwaffe. He served two tours with the Kondor Legion in Spain: the first as Chief of Staff, the second as commander with the rank of brigadier general. While in Spain he originated and codified the doctrine of air-ground support that the Wehrmacht later used so successfully and became known as the father of the ground attack arm. From 1939 to 1942 he led the VIII Fliegerkorps (Air Corps), a specialized ground attack command, on all fronts, and then commanded Luftflottes 4 and 2 (Fourth and Second Air Forces). Von Richthofen's high intelligence and energetic leadership gained him the respect of the faction-riddled Luftwaffe High Command. He was promoted to field marshal in 1943, the youngest member of the Wehrmacht to hold that rank, but a brain tumor forced him to take medical leave in 1944. He never returned to active service and died on 12 July 1945 in a U.S. military hospital in Europe.

Donald Caldwell

See also

Blitzkrieg; German Air Force (Luftwaffe); Spanish Civil War

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Rickenbacker, Edward Vernon (1890–1973)

One of history's greatest combat pilots, a pioneer airline executive, and an American hero whose name was once a household word among millions of admirers. He was born in Columbus, Ohio, on 8 October 1890. He anglicized his original surname, Rickenbacher, for professional purposes during his early career as an automobile racing driver but retained the Germanic spelling until 1918, when he was flying with the 94th Pursuit Squadron in World War I.

Working at the Oscar Lear Company, which made automobiles, Rickenbacker impressed his boss, Lee Frayer, by spending his lunch hours studying a mail-order course in automobile technology that he had bought on credit with his meager earnings. Taking Rickenbacker under his wing, Frayer taught him automotive engineering and took him to the 1906 Vanderbilt Cup Race as his riding mechanic. Thus began a career that would see Rickenbacker become a nationally famous race-car driver, winning $60,000 in 1916.

On a business trip to England, Rickenbacker resolved to become a combat pilot and emulate the exploits of U.S. volunteers who were fighting in the famed Lafayette Escadrille. After returning to the United States, he recruited a group of racers who hoped to become fliers and go to France under his leadership, but the Signal Corps rejected the idea. Its tradition-bound officials felt that Rickenbacker and his friends lacked the upper-class status and educational credentials that would make them officer material. This attitude would haunt—and inspire—Rickenbacker.

In late May 1917, while Rickenbacker was in Cincinnati getting ready for a Memorial Day race, an admirer, Major Lewis Burgess, telephoned him from Washington asking if he wanted to become a driver for General John Pershing and his staff, who were about to sail to Europe. Rickenbacker jumped at the offer and caught an overnight train to New York, where he enlisted the next day as a sergeant in the American Expeditionary Force. By evening he was aboard the *Baltic,* the oceanliner that took Pershing and his entourage across the Atlantic.

Whether Rickenbacker actually drove for Pershing himself is not clear. Lieutenant Colonel William "Billy" Mitchell, chief of the Zone of Advance, became aware of his mechanical ability and commandeered his services. Driving for Mitchell, Rickenbacker showed his mechanical genius by repairing his staff car in emergencies and gained his admiration. Rickenbacker was determined to escape being a driver as soon as possible and be transferred to the infant Air Service for flight training.

Rickenbacker took preliminary flight instruction at Tours, then at Issoudun. While doing his primary duty as an engineering officer, he became increasingly proficient in flying and persuaded Major Carl "Tooey" Spaatz (née Spatz), to post him for aerial gunnery training at Cazaux.

At both Issoudun and Cazaux, Rickenbacker was ostracized by pilot trainees with superior social backgrounds. Reed Chambers, a former National Guard pilot with modest origins, became an outcast for befriending Rickenbacker, beginning a lifelong comradeship between the two men. After completing gunnery school at Cazeau, Rickenbacker was sent for advanced combat-pilot training to an aerodrome at Villeneuve-les-Vertus and assigned to the 94th Pursuit Squadron.

Rickenbacker arrived at Villeneuve before his squadron had been equipped with French-built Nieuport 28s, a highly maneuverable plane that turned out to have serious structural defects. Major Raoul Lufbery, a phenomenal fighter pilot, was sent to the 94th as flight instructor. Lufbery saw Rickenbacker's enormous potential, became his mentor, provided him superb training, and paid him the honor of choosing him to fly in the first armed U.S. patrol across enemy lines on 28 February 1917.

After the onset of a major German offensive, the 94th was sent briefly to Epiez and then transferred to the Toul sector, a relatively inactive combat zone, to be seasoned for future operations against stronger German units. Rickenbacker grew increasingly adept in air-to-air combat. He scored his first victory in a sortie with James Hall on 29 April and won several more in May. Credit for one of these kills was denied him because Hall, its sole witness, was shot down behind enemy lines and became a German POW. As a result, Douglas Campbell, Rickenbacker's main rival, beat him out in winning the five official victories required to become the first U.S. ace. A more serious loss to Rickenbacker was the death of his mentor, Lufbery, on 19 May in an action over Maron, a village near Nancy.

Rickenbacker gained increasing esteem among his comrades as his valor and effectiveness in combat became more and more apparent. After Hall was taken prisoner, Rickenbacker became a flight leader in the squadron. He was also decorated with medals, including the Croix de Guerre. But flying at high altitude and executing dives and other sudden maneuvers took a toll on his ears. He also had a terrifying experience when he pulled out of a dive too sharply and began to lose fabric from his upper right wing. His Nieuport spun out of control and plummeted toward the ground until he finally managed to raise the nose of the plane, attain a horizontal position, and limp back to base.

By early June, as the Nieuports were replaced with more rugged SPAD XIIIs, Rickenbacker was sent to a hospital in Paris with an abscessed ear. After arriving in the city he learned that he had been credited with his fifth official victory and was now an ace. He returned to action for a short time but was soon prostrated by a mastoid infection and sent back to the hospital, where he languished for most of the summer while his unit—now facing the best planes and fliers the Germans had to offer—was suffering mounting casualties. Determined to return to the front, he spent his time thinking deeply about what he had already learned from his experiences and how he could correct his faults. By the time he went back into action, he had gained a maturity of purpose that transformed him from a mere ace into a supremely fearsome air warrior.

The SPAD XIII, which could dive at high velocity into a dogfight and exit with a speed that few airplanes could match, was well-suited to his fighting style. Like the cars he had raced before the war, it had the horsepower and structural integrity he craved. Throughout September and October, his hit-and-run tactics became a scourge to his opponents, and he ended the war with 25 official victories (21 against enemy airplanes, four against balloons). In time, the early kill he had scored during the mission with Hall was also credited to him, bringing his total to 26.

In late September, Rickenbacker also became commander of his unit and was promoted to captain. Determined to set the best possible example for his men, he went aloft the next day and took on seven German aircraft single-handedly, bringing down two and scattering the rest. For his gallantry in this action he was belatedly awarded the Medal of Honor in 1930. He came out of the war as America's ace of aces, with the Distinguished Service Cross and nine Oak Leaf Clusters and the French Croix de Guerre with three Palms. Soon after the war, he became a chevalier of the Legion of Honor. The 94th, acknowledged to be the best U.S. air unit of the war, received the honor of accompanying Pershing's army of occupation to Coblenz, Germany.

Rickenbacker returned home to a hero's welcome in February 1919. He continued to promote aviation and had a checkered career in the automobile industry, through no fault of his own. He became a successful executive with General Motors. In April 1938, he was able to purchase Eastern Airlines and build it into a highly successful company.

In February 1941, however, he was badly mangled when a Douglas DST crashed near the Atlanta airport. Initially given up for dead, he endured an agonizing recovery from multiple injuries, including a crushed hip socket, a broken pelvis, and a fractured knee. He was still recuperating when the Japanese attacked Pearl Harbor on 7 December 1941 and thereby plunged the United States into World War II. Despite his shattered condition, he volunteered for special missions for General Henry H. "Hap" Arnold, Chief of Army Air Forces, starting with an inspection tour of domestic military bases in March and April 1942. He went on another mission in September to inspect bases in England and reported on how to improve U.S. planes. He rejected appointment as a two-star general to preserve his independence on such tours.

On 21 October 1942, a Boeing B-17 carrying Rickenbacker from Hawaii to Canton Island, a refueling stop, had to be ditched in the ocean because of a navigational error that led it off-course. For three weeks Rickenbacker and seven companions, one of whom died at sea, drifted through shark-infested waters on three tiny rubber rafts and suffered from hunger, thirst, and exposure to the elements. His survival and rescue gave the American public a huge boost in morale at a major turning point in the war.

Rickenbacker's World War II experiences reinforced his heroic stature in the eyes of his fellow citizens. Returning to Eastern from his wartime missions, Rickenbacker presided for a time over the nation's most profitable airline but began making a series of decisions that adversely affected its interests. In 1958, he was shoved upstairs to chairman of the board and forced into unwilling retirement in 1963.

Rickenbacker fell ill with pneumonia and died in his sleep on 23 July 1973, a tragic hero yet considered by many to be a great man and a great American.

W. David Lewis

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Ridgway, Matthew Bunker (1895–1993)

U. S. Army general; pioneered airborne warfare in World War II and took the offensive against Chinese–North Korean forces in the Korean War.

As Army Chief of Staff (1953–1955), Ridgway criticized Air Force support of Army missions. Although he supported massive nuclear retaliation as a protective shield for the nation, he felt that the Air Force was putting too many resources into strategic bombers.

Believing that massive retaliation would not prevent limited wars, Ridgway wanted more aviation assets devoted to the Army. He wanted better close air support from low- and slow-flying aircraft, but the Air Force was developing jets that flew higher and faster. Ridgway also desired transports to deliver troops and supplies to unimproved fields in the combat zone, something C-123s and C-130s could not do. He believed that flying trucks and jeeps that could hop and skip about the battlefield would enhance mobility. Because the Air Force was not interested in giving greater support to these needs, Ridgway supported increased development of Army aircraft, especially helicopters.

Ridgway was thus not opposed to airpower; to the contrary, he wanted more airpower for the Army.

John L. Bell

Risner, Robinson (1925–)

U.S. Air Force brigadier general. James Robinson "Robbie" Risner was born in Mammoth Spring, Arkansas, on 16 January 1925. When he joined the Army Air Corps on his eighteenth birthday, an omission on his birth certificate forced him to enlist as "Robinson," whereupon he abandoned his boyhood name. He received his pilot wings in May 1944 and spent the remainder of World War II flying P-38 and P-39 aircraft in Panama.

Following the war, Risner served with the Oklahoma Air National Guard until recalled to active duty and assigned to Korea in May 1952. Flying the F-86 Sabre, he completed 109 combat missions, destroyed eight enemy aircraft, and became the twentieth jet ace of the Korean War. He subsequently commanded fighter squadrons in Germany and California and achieved fame by flying the Charles A. Lindbergh Commemoration Flight from New York to Paris on 20 May 1957, the thirtieth anniversary of Lindbergh's historic solo flight. Flying his F-100F *Spirit of St. Louis II,* Risner set an official transatlantic speed record of 6 hours, 37 minutes.

In August 1964, Risner accepted command of an F-105 Thunderchief squadron in Okinawa, Japan. His squadron deployed to Thailand in 1965, where he flew combat missions over North Vietnam and became the first recipient of the Air Force Cross. On 16 September, he was shot down and captured by the North Vietnamese. During his seven years in captivity, Risner served first as the senior-ranking U.S. officer, then as vice commander of the allied POW wing. After being repatriated in February 1973, he was promoted to brigadier general and continued to fly fighter aircraft as a wing and air division commander, then as vice commander of the USAF Fighter Weapons Center (Top Gun) in Nevada. Since retiring from the Air Force in July 1976, Risner has served as executive director of the Texans' War on Drugs and as a delegate to the United Nations General Assembly.

Paul G. Gillespie

See also

Prisoners of War

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Ritchie, Richard S. "Steve" (1942–)

U.S. Air Force brigadier general. Richard S. "Steve" Ritchie was born on 25 June 1942 in Reidsville, North Carolina. He was a star halfback at the United States Air Force Academy, leading the Falcons to the Gator Bowl in 1963. He graduated in June 1964 and, a year later, finished first in his flight-training class at Laredo AFB, Texas.

Ritchie's first assignment was with Flight Test Operations at Eglin AFB, Florida. In 1967, he transferred to Homestead AFB, Florida, for combat-crew training in the F-4 Phantom II. A year later, he was assigned to Da Nang Air Base, in South Vietnam, and flew the first F-4 forward air controller (FAC) missions in Southeast Asia.

In 1969, he returned home to the Fighter Weapons Center (Top Gun) at Nellis AFB, Nevada. Again he graduated tops in his class and soon became the youngest instructor in the school's history. In late 1971, Ritchie volunteered for a second tour in Southeast Asia. In January 1972, he joined the 432d Tactical Fighter Reconnaissance Wing, serving as wing weapons officer.

Between 10 May and 28 August, Captain Ritchie shot down five MiG-21s, becoming one of five U.S. aces (three Air Force, two Navy) during the Vietnam War and the only U.S. pilot ever to shoot down five MiG-21s. Ritchie downed two MiGs on 8 July in a classic low-altitude dogfight in which he outmaneuvered both enemy pilots. Since F-4D Weapon System Officers, or "backseaters," were given full credit for victories during Vietnam, it is worth noting that four of Ritchie's kills came with Captain Charles B. DeBellevue, the top U.S. ace in Vietnam with six victories.

Ritchie returned to the United States in late 1972 and retired from active duty in April 1974, later reaching the rank of reserve brigadier general. In recent years, he has flown a restored McDonnell F-4 at air shows to promote the USAF.

Among many awards, he received the Air Force Cross, four Silver Stars, 10 Distinguished Flying Crosses, 25 Air Medals, Air Force Meritorious Service Medal, Air Force Commendation Medal, 1972 MacKay Trophy, 1973 VFW Armed Forces Award, and 1973 Outstanding Young Man of America Award. He retired from the reserves on 29 January 1999 after more than three decades of service.

William Head

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Rocket Research in Germany (World War II)

Rockets had been used on both sides during World War I. Afterward, the Allied victors lost interest, focusing research efforts on tanks, planes, and other somewhat successful weapons from the war. Germany, however, continued to pursue rocket research. The Verein fur Raumschiffahrt (Society for Space Travel) was established in 1927 in Breslau. The first successful rocket test took place in 1930, with other tests following, but by 1934 the amateur society was defunct. The German army took over rocket-testing, consistent with its practice from the 1920s of working illegally with Russia on weapons research. The army sought a better artillery weapon, so the research was in the ordnance department.

In 1932, Wernher von Braun joined army rocket research at Kummersdorf. The first test of a 650-pound/thrust motor fueled with alcohol and liquid oxygen fed into the combustion chamber by nitrogen failed when the engine blew up. Undaunted, von Braun and staff designed the Aggregate 1 (A-1) rocket.

The A-1 was approximately 4.5 feet long with a 1-foot diameter and a takeoff weight of 330 pounds. The engine developed 650 pounds of thrust for 16 seconds. Stabilization was built in as a design factor. The nose of the rocket spun, serving as a gyroscope; before launch, an electric motor revved it to 9,000 rpm, and it ran down during flight. The first three A-1 tests at Kummersdorf failed.

Even before the first A-1 test, the A-2 was designed with the same 650-pound/thrust engine but separate fuel and liquid oxygen tanks with a gyroscope in the middle close to the rocket's center of gravity. A-2 tests relocated from Kummersdorf to preserve secrecy (by this time the Nazis were in power and suppressing information and amateurs). Von Braun's 1934 Ph.D. thesis referred to his work as "combustion experiments."

In December 1934, two A-2s were launched successfully at Borkum (and were named *Max* and *Moritz,* the Katzenjammer Kids) from a 40-foot launch platform. They attained 1.4 miles of altitude and landed, with a parachute assist, approximately 800 meters from the launchpoint. When the army asked him about the weapon potential of the A-2, von Braun noted that conventional artillery had the same capability.

In March 1935, Hitler repudiated the Versailles Treaty, and the buildup was on. Kummersdorf was renamed Experimental Station West. The A-3 was on the drawing board, and the Army Ordnance Office began a cooperative effort with the Luftwaffe that eventuated in the special-weapons development center at Peenemünde.

Peenemünde was in northern Usedom. Its conversion to a test center began in 1936. By 1937, the Kummersdorf contingent could relocate all their work, except for engines, which remained at Kummersdorf until 1940. Peenemünde provided a clear, 300-kilometer firing range, harbors, and all other required facilities. Most noteworthy was its supersonic wind tunnel, which initially was smaller than the one at Aachen that tested up to Mach 3.3. By 1942, the capability of the wind tunnel at Peenemünde exceeded Mach 4.4, the best in the world until after the war. Peenemünde also had a rocket production facility.

The A-3 was 21 feet, 8 inches long, 2 feet, 4 inches in diameter; its takeoff weigh was 1,650 pounds. Inside the nose was a telemetry package to measure heat and pressure during flight. There was a guidance system to control attitude, a liquid oxygen tank and nitrogen reservoir, and a parachute container. In the rear was the 6-foot-long motor, encased in the alcohol tank, with 1.5 tons of thrust. The rocket had four fins and jet vanes in the nozzle for better early-flight control and in the thin upper atmosphere, where fins were ineffective.

The A-3 took nearly two years to build because of difficulties developing a guidance system. A combination of four gyroscopes spinning at 20,000 rpm to control yaw and pitch helped keep the rocket level. The 1937 test on the island of Greifswalder Oie failed because the gyro system couldn't control beyond 30 degrees and couldn't correct the A-3's tendency to turn into the wind. Because the A-3 hadn't burned or exploded, the group felt confident enough to develop a small A-5 to refine the new technologies. The A-4 was the designation for the military rocket that became the V-2. The V-2 became the experimental vehicle for both the United States and the Soviet Union. Von Braun led the U.S. space effort for many years.

John Barnhill

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Rockwell International

Major U.S. defense contractor. The Rockwell Standard Company was started in 1919 as an autoparts factory in Wisconsin and evolved into one of the largest manufacturers of defense and aerospace products in the world. In 1966, Rockwell and North American Aviation merged to form North American Rockwell Corporation. The new company continued contracts for the Apollo lunar spacecraft, as well as various engines for the Saturn, Thor, and Atlas rockets and the Sidewinder and Sparrow air-to-air missiles. By 1973, the Rocketdyne Division had built more than 8,900 large rocket engines. The Atomics International Division had built prototype liquid-sodium nuclear reactors and was working on the first large-scale demonstrator of a breeder reactor. Autonetics was producing guidance systems for a variety of aircraft, missiles, and ships. What was not being produced, in any great number, were aircraft.

In 1973, North American Rockwell acquired Collins Radio, a leading producer of aircraft avionics, commercial telecommunications, and communications systems, and the company changed its name to Rockwell International. This expansion into electronics was subsequently increased with the purchase of Milwaukee-based Allen-Bradley in 1985 and, a decade later, the acquisition of Reliance Electric, an industrial motor, drive, and transmission company.

While under the Rockwell name, very few aircraft were produced. The six Space Shuttle orbiters, four B-1A prototypes, and 100 production B-1B bombers were the most notable, although the two X-31 high-alpha demonstrators were also manufactured.

On 6 December 1997, Rockwell International announced that it was selling its aerospace and defense divisions to Boeing, which attempted to preserve some of the heritage by naming its new division Boeing North American. The Boeing North American operation performs modifications to operational B-1B bombers, has participated in the Lockheed

X-33 program, and assisted building the two X-32 Joint Strike Fighter demonstrators.

Dennis R. Jenkins

ROLLING THUNDER (1965–1968)

U.S. code name for bombing of North Vietnam from 2 March 1965 to 31 October 1968—the longest bombing campaign ever conducted by the U.S. Air Force. It was also one of the least decisive, most costly, and intensely controversial bombing campaigns in U.S. history.

ROLLING THUNDER had two objectives. It began as an attempt at strategic persuasion: forcing Hanoi to stop supporting the Vietcong and negotiate and end to the conflict. In July 1965, when the United States committed the Army and Marine Corps to the ground war and large numbers of U.S. servicemen and women were sent to South Vietnam, ROLLING THUNDER switched its primary objective from strategic persuasion to interdiction in an attempt to reduce the flow of troops and supplies moving from the North into the South. From July 1965 through October 1968, ROLLING THUNDER remained primarily an interdiction campaign, although elements of strategic persuasion operated concurrently.

To accomplish the campaign's objectives, the Air Force, Navy, and Marine Corps bombed military installations to include radar sites, barracks areas, and some airfields. Petroleum storage facilities (North Vietnam had no refineries), railyards, rail and highway bridges, and ammunition depots were struck. The bombing began modestly, constrained to the southern panhandle of North Vietnam, and moved steadily northward, increasing in scope and intensity through the spring and summer of 1965. Generally, the Air Force struck targets in the northern and western parts of North Vietnam and in the southern panhandle while Navy and Marine aviators, flying from aircraft carriers on Yankee Station in the Gulf of Tonkin, hit targets in the western part of the country and along the coastal plain. The Air Force relied on the Republic F-105 Thunderchief, or "Thud," and the McDonnell F-4 Phantom II to carry the brunt of its bombing to the North Vietnamese heartland. The Navy and Marine Corps flew fighter-bombers like the F-4 Phantom, A-4 Skyhawk, all-weather A-6 Intruder, F-8U Crusader, and A3D Skywarrior twin-engine bomber. Over the course of the campaign, the Air Force flew some 2,360 B-52 sorties against targets in the southern panhandle.

North Vietnam's air defenses increased in sophistication when the Soviet Union and the People's Republic of China provided what became one of the world's most potent air defense systems. It included SA-2 surface-to-air missiles (SAMs) that forced U.S. aircraft to approach their targets at altitudes as low as 500 feet and along a gauntlet of antiaircraft fire from 23mm, 37mm, and 57mm guns, many of which were radar-controlled. The North Vietnamese incorporated their population into air defense so that hundreds of thousands of people were given rifles and machine guns to blaze away at the hated Yankee air pirates.

As if SAMs, antiaircraft guns, and an aroused populace were not enough, the North Vietnamese possessed a healthy stable of interceptors. Planes like the MiG-17, MiG-19, and MiG-21 all proved to be highly maneuverable and somewhat more capable than many U.S. airmen originally thought. Air-to-air action was the exception rather than the rule, but it did take place, with the United States losing 67 planes in dogfights while downing 137 aircraft for a kill ratio of about 2.2:1 in the U.S. favor.

During ROLLING THUNDER, the Air Force, Navy, and Marines flew nearly 1 million sorties against North Vietnam, some 600,000 of which were strike sorties. Estimates are that airpower destroyed 77 percent of all ammunition depots and 65 percent of the enemy's petroleum storage facilities. Bombing degraded electric-power generating capabilities by more than 50 percent and brought down 55 percent of North Vietnam's bridges.

But ROLLING THUNDER failed to achieve its strategic objectives in that the North Vietnamese did not agree to negotiate until the United States agreed to stop the bombing; the flow of troops and supplies moving from North to South doubled each year from 1965 through 1968.

ROLLING THUNDER was a strategic failure in the classic sense because conventional airpower was used against the North in an attempt to affect an unconventional war in South Vietnam. There are three reasons. First, North Vietnam was a preindustrial agricultural power not susceptible to the kind of bombing that helped defeat Japan and Germany in World War II, but airpower leaders never understood that. Second, Washington exercised far too much control over the targeting process, which was convoluted, inefficient, and ineffective. Third, North Vietnam proved to be much more determined than was the United States.

Estimates are that it ultimately cost the United States $6 for every $1 in damage inflicted on the North. It also cost about 770 Air Force, Navy, and Marine aircraft and more than 600 aircrewmen killed, captured, or missing in action. In the end, ROLLING THUNDER is best described with a line from Shakespeare's *Macbeth:* "Full of sound and fury, signifying nothing."

Earl H. Tilford Jr.

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Rosendahl, Charles E. (1892–1977)

U.S. Navy vice admiral. Charles Emery Rosendahl was born in Chicago on 15 May 1892. Attending public schools in Kansas and Texas, he was appointed to the U.S. Naval Academy and graduated with the class of 1914.

Rosendahl held duty aboard various surface units, notably destroyers, and a postwar tour as instructor at Annapolis. In April 1923, he reported to the Naval Air Station in Lakehurst, New Jersey, for training in lighter-than-air craft. Designated naval aviator (airship) on 22 November 1923, Rosendahl was detailed to duty in the rigid airship USS *Shenandoah* (ZR-1). The lieutenant was navigator and senior survivor when the ship was torn apart by severe atmospheric instability near Ava, Ohio, in September 1925. Following the inquiry, which made the young officer a public figure, Rosendahl was ordered to duty as executive officer of USS *Los Angeles* (ZR-3), the U.S. Navy's most successful rigid. In May 1926, he assumed command, serving aggressively as skipper for three years. Relieved temporarily, "Rosie" accompanied the first westward crossing of the North Atlantic in *Graf Zeppelin* in October 1928 and, in 1929, was guest aboard the peripatetic Zeppelin during its round-the-world flight.

After service in the Plans Division of the Bureau of Aeronautics, he assembled the nucleus crew of USS *Akron* (ZRS-4) and had charge of fitting out that fleet airship—a strategic aerial scout that carried airplanes. He flew ship's trials and assumed command when ZRS-4 was placed in commission in October 1931, retaining command until relieved for line duty in mid-1932. From June 1934 through August 1938, Rosendahl was back as commanding officer of the Lakehurst Naval Air Station. During that tour, the lieutenant commander (and fellow naval airmen) served as U.S. naval observer aboard *Hindenburg* as it plied the North and South Atlantic and was on the landing field when *Hindenburg* took fire on 6 May 1937.

The years 1938–1940 saw further sea duty, this time as executive officer of USS *Milwaukee.* Then came duty in Washington in the office of the secretary of the Navy, the office of the Chief of Naval Operations, and the Bureau of Aeronautics, assignments in which he pressed for and planned the expansion of naval lighter-than-air aircraft to help fight World War II. The primary mission of the nonrigid airship, or blimp, was antisubmarine warfare.

In September 1942, Rosendahl assumed command of USS *Minneapolis.* The cruiser lost its bow to Japanese torpedoes off Guadalcanal but continued its engagement with the enemy before withdrawing for major repairs. The incident earned its commander a Navy Cross. From *Minneapolis,* Rosendahl was ordered to the States, promoted from captain to rear admiral, and assigned duty as chief of naval airship training and experimentation at Lakehurst, a new billet inspired by the contributions of Lighter-than-air (LTA) operations in the Atlantic and Pacific Fleets, including the Caribbean, South American, and western Mediterranean Theaters. In addition to this, the admiral was special assistant for LTA to the deputy Chief of Naval Operations (Air).

Charles E. Rosendahl was transferred to the retired list of the Navy in November 1946, with the rank of vice admiral. By sheer force of personality, his commands and tireless advocacy, the Rosendahl name is virtually synonymous with lighter-than-air aeronautics.

William Althoff

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Royal Aircraft Factory

One of the five original components of the Royal Flying Corps; originally intended to act as a repair station for damaged aircraft. In its two years of peacetime operation, however, the definition of "repair" was so liberally interpreted that by the outbreak of war (the name was changed in 1918 to Royal Aircraft Establishment to avoid confusion over the acronym assumed by the Royal Air Force) it had clearly become a research and design facility as well.

Before and during the war years, it turned out original designs in several categories, all with the common word "experimental" in their title, a nod to the research role the factory had assumed. Thus are seen the "BE" (some accounts say the "B" stands for "Blériot," others for "Bombing"), the "FE" (Fighter Experimental), "RE" (Reconnaissance Experimental), and "SE" (Scouting Experimental). The lines frequently became blurred, resulting in considerable functional overlap between the BE and RE types and the FE and SE types.

The activities of Royal Aircraft eventually threatened private manufacturers, who were highly critical of what they

Perhaps the finest of the designs of the Royal Aircraft Factory, the SE 5a fought well on the Western Front and was used in limited numbers in the postwar years by the U.S. Army Air Service. (U.S. Air Force)

saw as a Royal Flying Corps manufacturing preference for its own types. Many were driven as a result into closer business relationships with the Royal Naval Air Service (RNAS) and the British Admiralty. This became a factor in the interservice rivalry that developed between the RFC and the RNAS and was of more than casual importance in the decision to merge the two into the Royal Air Force.

Royal Aircraft designs spanned the quality scale from the distinctly inferior BE 2, through the slightly better RE 8, to the truly outstanding SE 5/5a fighter.

The SE 5a was the aircraft to which any British neophyte fighter pilot would want to be assigned. It was fast, strong, easy to fly, well-armed (with a synchronized Vickers and a wing-mounted Lewis), and lacked the fatal habits that characterized its contemporary, the Sopwith Camel.

Built around the Wolsley Viper engine, a British copy of the direct-drive Hispano Suiza, the SE 5a was designed for high-altitude fighter patrols. In the hands of pilots like James McCudden, who scored 50 of his 57 victories on the type, the SE was a truly dangerous fighter, every bit the equal of the Camel or any of its German rivals.

James Streckfuss

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Royal Australian Air Force (RAAF)

The Royal Australian Air Force had its humble beginnings in September 1912 as the Australian Flying Corps when a flight of four aircraft was authorized for the army. In 1913, its first two pilots went to England and returned with five aircraft and number of maintenance personnel. A total of 2,275 RAAF personnel served with British aviation forces during World War I.

Starting in January 1929, brushfire-spotting became a new mission for the RAAF. This was followed a year later by dusting for pest control.

With World War II looming, two major training expansions were instituted in 1938 and 1939. Plans were made for 32 squadrons with 360 aircraft in June 1940, but this was increased to 73 squadrons in May 1941. The RAAF began combat operations during World War II in the Southwest Pacific alongside U.S. forces. Eventually, the RAAF had squadrons fighting in almost every theater of the war. By the end of World War II, the RAAF comprised 3,187 first-line aircraft dispersed in 52 squadrons. Their missions included fighter, bomber, reconnaissance, antisubmarine, clandestine operations, and transport.

The first jets to enter RAAF service were de Havilland Vampires in May 1946. These were followed by Gloster Meteors and North American Sabres. The RAAF was part of the UN operation in Korea, employing its Meteors.

When the South Vietnamese government asked for assistance through the Southeast Asia Treaty Organization, the Australians joined the anticommunist efforts. During the Vietnam War, RAAF Bell Iroquois helicopters supported Australian ground forces. An RAAF English Electric Canberra squadron served alongside a USAF Martin B-57 Canberra wing for more than four years. Another RAAF squadron provided airlift support operations with de Havilland Caribous between 1964 and 1971.

Maritime patrol operations began in World War II with Avro Lancasters and Consolidated Liberators. Subsequently Avro Lincolns were employed along with a number of large flying boats. This mission was then performed by Lockheed Neptunes and, later, Lockheed Orions.

During the early 1970s, the RAAF leased 24 USAF McDonnell F-4E Phantom IIs until they were replaced by the General Dynamics F-111C. The Lockheed Hercules entered the RAAF inventory in 1958 and has since became the mainstay of RAAF transport units.

Wherever and whenever called upon, the RAAF has served Australia, the British Empire, and the United Nations. A staunch supporter of U.S. interests, RAAF personnel bring professionalism to every operation they undertake.

Alwyn T. Lloyd

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Royal Bulgarian Air Force

Bulgaria had originally been among the pioneers in the use of airpower, a Bulgarian Blériot XI dropping grenades on the Turkish fortress of Odrin. Yet for most of its existence, the air force of Bulgaria has never been among the largest, or even most important, of the world,

After World War I, Bulgaria built aircraft in the national airplane factory Dazhavna Aeroplanna Rapotilnitsa and purchased others from abroad for use in civilian roles. At the same time, a secret air component of the army, the Vozdushni Voiski, was established.

The expansion of the air component of the army began in 1935, when the first air wing, comprising one fighter, one training, and two reconnaissance squadrons, was established. The air force was reformed illegally in 1936, with the aim of forming four wings during 1937–1939. In July 1938, when the constraints imposed upon Bulgaria by the post–World War I peace were lifted, Bulgaria was finally able to reveal the existence of the air force to the public.

Although the first actual combat aircraft to arrive were Polish PZL P.24B fighters and P.43A light bombers, the largest group of planes represented remnants of the Czechoslovakian air force that Germany had seized when occupying the remaining parts of Czechia in March 1939. Thus, Bulgaria received 78 Avia B.534 fighters, 24 Avia B.71 medium bombers, 62 Letov S.328 army cooperation planes, and 12 Aero MB.200 bombers; the air force expanded to five air battalions (or squadrons). But with this sudden expansion came an urgent need for trained pilots, and 160 Bulgarian pilots received training in Italy, Hungary, and Germany.

During 1940 and 1941 expansion continued, a number of additional air battalions were formed, and Bulgaria received 11 modern Dornier Do 17Ms. Furthermore, the air battalions were now organized into four air regiments. In all, these contained 561 machines, with 411 operationally ready.

During the Axis invasion of Yugoslavia (for which Bulgaria provided bases), a number of attacks by Yugoslav and British bombers were experienced. When the Allies bombed the Ploesti oil fields later in the war, Bulgarian aircraft attacked with former Czech aircraft and some German Messerschmitt Bf 109s. Bulgaria also received 96 former Vichy French Dewoitine D.520s and some additional Dornier Do 17s.

On 10 January 1944, 180 B17s with heavy fighter escort attacked the Bulgarian capital of Sofia. Some 70 Bulgarian and 30 German fighters rose in its defense, but the destruction wrought upon the capital was severe, with 4,100 buildings reduced to rubble.

Although Allied bombings of Bulgaria remained few in number, their impact was heavy. The Soviet invasion and subsequent coup on 10 August 1944 brought about the inevitable, and Bulgaria declared war on Germany on 5 September.

The following two months saw the Royal Bulgarian Air Force flying 4,400 missions against Axis forces in Macedonia, Serbia, and Kosovo, losing 23 aircraft. The air force received 120 Yakovlev Yak-9 fighters and 120 Ilyushin Il-2 ground attack planes but continued to use German Messerschmitt Bf 109Gs and Junker Ju 87Ds (the famous Stuka) against its former ally. After World War II Bulgaria became part of the Soviet bloc, and the Bulgarian Air Force flew Soviet equipment.

Henrik Krog

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Royal Canadian Air Force

See Canadian Air Force

Royal Flying Corps (RFC)/Royal Naval Air Service (RNAS)/Royal Air Force (RAF)

British military aviation has its roots in the Royal Engineers, which established a balloon corps in 1908. In May 1912, the Royal Flying Corps was established with a military wing, which worked for the army; a naval wing for operations with the fleet; the Central Flying School for instructional purposes; a repair depot called the Royal Aircraft Factory; and a reserve.

A form of interservice rivalry developed almost at once between the military and naval wings, and shortly before the declaration of war, in the summer of 1914, the naval wing broke away to become the Royal Naval Air Service.

When war was declared, the RFC deployed with the British Expeditionary Force; an aircraft park and four squadrons (Nos. 2, 3, 4, and 5), each equipped with the entire mixed bag of aircraft then in the British inventory. After a series of moves necessitated by the initial British retreat, headquarters in France was established at Saint Omer, where it remained for most of the war. The first field commander of the RFC was Brigadier General David Henderson. Henderson would shortly return to England, though, leaving command in the field to Hugh Montague "Boom" Trenchard.

Initially, each RFC unit acted as something of a self-contained air force, performing the complete range of activities, which at the time consisted primarily of reconnaissance duties with the occasional bombing mission. As the war progressed, the force grew in number, and by 1916 squadrons began to specialize either as fighter, bombing, or reconnaissance units, the latter role being further divided into photographic and artillery functions. As a consequence of specialization, the practice of units having a multiplicity of types was abandoned, and squadrons started to become known not only by their role but also by what type of equipment they possessed. Balloon companies using tethered observation balloons as artillery spotters began appearing in British service in 1915 and remained a fixture on the Western Front throughout the war.

Technological advances were rapid during the war, and keeping up with the enemy in the design and deployment of new types was a constant problem. The British sometimes suffered severely as a result. When the Germans were first to develop an interrupter gear—allowing a machine gun to fire through the propeller arc—the RFC found itself on the receiving end of the "Fokker scourge." During the spring of 1917 the problem reached a crisis. During the Battle of the Somme, the previous autumn, the Luftstreitkräfte (Air Service) had organized its single-seat fighter force into heterogeneous *jagdstaffeln* (fighter squadrons) and reequipped with the Albatros D.I and D.II. The type had been refined over the winter into the D.III.

The RFC, however, had lagged in the introduction of new types and went into the spring with the same complement of tired aircraft, mostly BE 2s that had been in use for the last two years. It paid a high price—the highest number of casualties in a single month it would suffer during its existence—a month that went down in history as "bloody April."

Technological advantage was not the only factor in these losses; doctrine also played a part. Throughout the war, Trenchard followed an offensive policy. This action has attracted its share of criticism, but faced with German occupation of the high ground and the insatiable intelligence needs of the army, often only satisfied by aerial reconnaissance, the RFC seems to have had little choice but to press on with what it had.

The situation improved over the summer of 1917 with the introduction of the Sopwith Camel, the SE 5/5a, the de Havilland D.H. 4, and the Bristol Fighter; the SE 5/5a was the best design to emerge from the Royal Aircraft Factory during the war, the other three, of course, being the products of private firms. From that point on, technology remained fairly balanced, and casualties returned to a manageable level until spiking again in September 1918 following the German introduction of the BMW-powered Fokker D.VII.

The Royal Flying Corps did not operate exclusively on the Western Front, however. After some initial jurisdictional feuding with the RNAS, the RFC had assumed responsibility for the aerial home defense of Great Britain, thereafter regularly scrambling a hodgepodge of mostly second-line equipment in response to Zeppelin and Gotha attacks.

Outside of England and France, units also served in Egypt and Palestine, Mesopotamia, and Russia, providing support to British army operations in those theaters.

The Royal Naval Air Service mission was primarily, if not exclusively, the support of British maritime endeavors. This covered a wide range of activities, from antisubmarine patrols and general reconnaissance duties in connection with the fleet, to bombing missions against submarine pens and Zeppelin bases. To fulfill these missions, the RNAS developed a varied inventory that included floatplanes, flying boats, the first experimental torpedo-bombers, and lighter-than-air airships. Ships were also adapted to work with aircraft, leading to the balloon ship (which extended the effective range of vision of the group to which the balloon vessel was attached), the crane-equipped seaplane carrier, and, eventually, to the first flight-deck aircraft carriers.

In addition to new equipment, innovative techniques were also developed for work over the water, one of the most useful to the prosecution of the war being the so-called spider web. The spider web was an invisible grid over the English Channel and North Sea that provided an organized method for aircraft to use in searching for underwater mines and U-boats. Provision for aerial escort as part of the convoy scheme also contributed to the safety of Allied shipping as it crossed the Atlantic to and from North America.

As mentioned, the RNAS did not operate exclusively over the water. Throughout the war, naval units were deployed for land-based operations on the Western Front. And among the Allied forces, the RNAS could take credit for the first tentative attempts at strategic bombing. In the summer of 1916, the RNAS organized No. 3 Wing and equipped the unit with Sopwith 11/2 Strutters and Breguet bombers with the aim of attacking targets inside Germany. The group was stationed at Luxeuil, near Nancy, putting it within reach of manufacturing plants in the Saar River Valley. Bad weather—the perpetual enemy of aerial operations—kept No. 3 Wing grounded throughout much of its life, but its first—and most memorable—raid took place on 12 October 1916 when it attacked the Mauser Works at Oberndorf. The raid was a truly international operation involving not only the British naval unit but also French bombers and an escort of Nieuport fighters provided by the U.S. volunteers of the Lafayette Escadrille. By spring, however, the lackluster results achieved led to the breakup of the group and the reassignment of its crews to other units, many going to the navy's single-seat squadrons up near the channel coast. There, some pilots, such as Canadian ace Raymond Collishaw, would go on to great success flying the Sopwith Pup, Triplane, and later the immortal Camel, supplementing the RFC in support of army operations.

Relations between the two British aviation services were always somewhat tense, accusations of various intrigues going in both directions. The rivalry heightened to the point that a government committee merged the RFC and RNAS into the Royal Air Force on 1 April 1918.

Trenchard was ordered to run the Independent Force and General John Salmond became the RAF's first field commander. There is little evidence to indicate that a true merger of the two services really took place prior to the Armistice, however. There was a new "RAF blue" uniform issued, but not many people are seen wearing it in wartime photos, most clinging not only to the old uniform but also to the practices and brief traditions of their earlier branch. Previously, naval squadrons were renumbered, each having "200" added to its original designation (e.g., Naval Eight became No. 208 Squadron, RAF), and a few swaps of personnel were effected, probably the most notable being the transfer of RNAS ace Roderick Dallas to the command of No. 40 Squadron, an old RFC fighter unit. But these changes were largely cosmetic, and the real birth of the Royal Air Force is more likely found in the postwar struggles to remain funded and stay alive, all taking place under the stewardship of Trenchard. The fruits of his labor became apparent in 1940 when the RAF rose to the Nazi threat and achieved its finest hour during the Battle of Britain.

James Streckfuss

See also
World War I Aviation

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Royal Norwegian Air Force (RNAF)

Independent air service formed by Norway in November 1944. Its principal tasks today are to ensure the territorial integrity of the country, ensure the safe reception of allied forces sent in support of Norway, and contribute to NATO operations. The RNAF is part of the Norwegian Total Defense Concept, with an emphasis on defending its territory; the combat-aircraft element is focused on air defense.

The RNAF holds 58 updated F-16s as its most important weapons system within the air defense role, but together with four updated P-3C Orions it also plays an important part in maritime operations. In addition, the RNAF works closely with other NATO countries in the Air Command and Control System (ACCS) program. The ACCS integrates the command-and-control system in order to meet the requirements of identifying and destroying hostile sorties.

Under the two principal subordinate commands, COMNON and COMSONOR, the RNAF organization consists of various air bases and radar sites. The air defense is organized as a network where the most important air bases are defended by NASAMS, the Norwegian advanced surface-to-air missile system, integrated with RB 70 missiles and, in the event of mobilization, L 70 guns.

The RNAF is in the process of reorganization, and its current peacetime organization consists of 5,800 officers and civilians and 2,700 conscripts. The RNAF participated in

Operation ALLIED FORCE with F-16s, conducting combat air patrol. Although the organization has a history of international engagements, including the use of C-130s and helicopters, it is increasingly adapting to participation in future peacekeeping and peace-enforcement operations. As such, the RNAF has a national as well as an international edge through its Immediate Reaction Force, located at the main air base in Orland.

John Andreas Olsen

Royal Thai Air Force (RTAF)

Military aviation in Thailand (Siam until June 1939) began in February 1912 when the Ministry of War sent three officers to France for pilot training. When they returned with eight French-built aircraft in November 1913, they were formed into the Army Aviation Section. On 27 March 1915, shortly after the airmen moved into their permanent home at a newly constructed airfield at Don Muang, outside Bangkok, the Ministry of War reorganized the Aviation Section into the Army Flying Battalion, under the command of French-trained Lieutenant Colonel Phraya Chalerm Akas.

King Vijiravudh was an enthusiastic supporter of the country's growing air force. The monarch believed that aviation promoted national unity, fostered a spirit of modernity, and enhanced prestige in the world community. Army Chief of Staff Field Marshal Prince Chakrabonse Bhuvanart also led the way in promoting aeronautical development. In 1983, in grateful memory of his assistance during its formative years, the air force placed a statue of the prince in front of headquarters, inscribed "The Father of the Royal Thai Air Force."

The government sent an aviation contingent to France in June 1918, but the war ended before the Siamese pilots entered combat. Nonetheless, the decision to assist the French not only increased the kingdom's prestige but also allowed the air force to gain valuable experience. On 19 March 1919, the Flying Battalion became the Aeronautical Department of the Army, with three operational flying units (pursuit, observation, bombardment). A further reorganization took place on 1 December 1921 when the air component was renamed the Department of Aeronautical Service (more familiarly, the Royal Aeronautical Service). At the same time, the air force was designated as a special service with a separate budget, although it remained under the direct control of the commander in chief of the army.

The air force achieved complete independence on 9 April 1937 as the Royal Siamese (soon Thai) Air Force within the Ministry of Defense. The airmen adopted the blue uniforms and rank designations of the Royal Air Force. Group Captain Phra Vechayan Rangsarit became the service's first commander.

By 1940, the RTAF boasted five fighter squadrons and six bomber squadrons, equipped with Curtiss Hawks, Vought Corsairs, and Martin 139 WSs. This force fought a border war with French Indochina in the winter of 1940–1941, claiming five French planes shot down at a cost of three Thai losses.

The RTAF flew briefly against the Japanese in early December 1941. The government then concluded a military alliance with Tokyo. The air force operated, without great enthusiasm, under Japanese direction until it shifted to support Thai resistance in the later stages of World War II. By war's end, the RTAF had reached its nadir, with less the 50 percent of its aircraft in serviceable condition.

A new era dawned on 17 October 1950 when Thailand and the United States signed a mutual defense assistance agreement. The RTAF was reorganized along U.S. lines and reequipped with U.S. aircraft. It subsequently sent transport contingents to assist the United States during the Korean and Vietnam Wars. By 2000, the RTAF's inventory consisted of 153 combat aircraft, including one squadron of F-5 A/Bs and two squadrons of F-16 A/Bs. Although not the largest air force in Southeast Asia, the well-trained RTAF stood ready to protect its country's borders, as it had since its inception.

William M. Leary

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Royal Yugoslav Air Force (RYAF)

The history of Yugoslavia's air force started in 1923, when the army spun off its air units to a separate arm. They had seen their first post–World War I combat four years earlier when Austrian and Slovenian planes battled each other in the skies over the region of Karinthia.

Equipped with French remnants after World War I, the air force was expanded to two air regiments, one at Novi Sad and one at Mostar, of six squadrons each. Indigenous aircraft manufacture began in the 1920s with Rogozarski, Ikarus, Zmaj, and DFA, which began producing large numbers of primarily French but also German planes under license.

As Germany and Italy undertook expansionist policies, the need for a larger air force was obvious. Yugoslavia faced the Nazi invasion on 6 April with a highly diverse mix of aircraft that were not yet familiar to all pilots. Among the 487 airworthy planes of the air force (including the marine air element) were British Hurricane, German Messerschmitt Bf 109, and Yugoslav Ikarus IK-2 fighters, as well as British Bristol Blenheim, German Dornier Do17, and Italian Savoia-Marchetti SM.79 bombers. These were organized for the most part into four air brigades and some miscellaneous units.

The German attack opened with a thorough bombing of the capital of Belgrade, lasting two days and totally overwhelming the Yugoslav defenses. The odds against the RYAF were simply too great. When an armistice was signed on 17 April, only 11 days after the initial attack, the force was essentially crushed. Only 44 planes managed to make it out of the country to the Greek airfield at Ioannina but were subject to a German attack there. Only six bombers and 10 seaplanes escaped to Egypt. There, they were formed into Nos. 1 and 2 Yugoslav Squadrons, but they were progressively weakened by losses of planes; by 1942 both had disbanded, the pilots going to other RAF units. Some elements of the RYAF, for a very short time, became part of the partisan movement.

Major expansion came in 1944, when an agreement was made between the Partisans and the royal government-in-exile. As a result, new air units were formed in the Middle East from former RYAF aviators and pilots flown out from occupied Yugoslavia. Two squadrons were formed in the Middle East. The 1st and 2d Yugoslav Fighter Squadrons became the 352d and 351st Yugoslav Squadrons RAF on 22 April and 1 July and, after intensive training, transferred to Italy, then to the island of Vis in the Adriatic Sea, and finally to Skabrnje airfield near Zadar on the Yugoslav mainland. When World War II ended, the two squadrons were organized into the 1st Fighter Regiment before being disbanded as RAF units on 15 June 1945, the equipment being transferred to Yugoslavia's air force.

At the same time, the Partisans requested help from the Soviets (who had entered Yugoslav territory in the fall of 1944) in forming air units. Group Vitruk, a Soviet air corps consisting of the 10th Guards Assault Air Division and the 236th Fighter Air Division, was transferred to Yugoslavia and took on Yugoslav personnel as extras, trained to do the same tasks as the Soviets. Then in December 1944, they formed three fighter and three air assault regiments with mixed Soviet-Yugoslav crews, who were later subordinated to the new Yugoslav 11th Fighter Air Division and 42d Assault Air Division.

Combat was first joined by Yugoslav pilots on 17 January 1945 on the Syrmian Front, and the two air divisions were taken over by a Yugoslav HQ in March 1945, when the Group of Air Divisions of the (Yugoslav) Army was formed. On 1 April the first independent Yugoslav unit was formed at Klenak airfield from the 112th Fighter and 422d Assault Regiments, which had been transferred there on 29 March. This Air Group South was to support the final offensive of the Yugoslav army. On 12 April 1945, they undertook the largest Yugoslav air offensive of World War II, when 180 planes launched simultaneous attacks on Axis installations in preparation for the final Yugoslav offensive. Yugoslav planes flew primarily harassing missions until the war ended on 7 May 1945.

Yugoslav planes did not cease operations, however, and continued flying missions until 25 May 1945 against its own citizens—Croat, Serbian, and Slovene nationalists refusing to give up in the face of the communist-dominated Partisans.

Henrik Krog

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Rudel, Hans-Ulrich (1916–1982)

Luftwaffe colonel; by any standard the most successful military aviator in history. He joined the Luftwaffe in 1936 as an officer candidate and, after completing flight training in 1938, was assigned to a unit equipped with the Junkers Ju 87 "Stuka" dive-bomber. He was apparently a slow starter and lost his pilot status temporarily. He participated in the Polish campaign as an observer in a reconnaissance unit and did not rejoin the Stuka force until he had received additional training.

Rudel's star began to rise with the German invasion of Russia in June 1941. He first came to the attention of the German public that September, when he dive-bombed and sank the Soviet battleship *Marat.* He continued to fly ground support missions on the Eastern Front for the rest of the war, taking only brief respites to recover from injuries. In late 1944, Rudel was promoted to colonel and given command of the last day unit still flying the Ju 87, Schlachtgeschwader 2 (SG 2; 2d Ground Attack Wing). He was awarded successively higher decorations, in the German custom, and on 1 January 1945 was summoned to Hitler's headquarters to receive a new supreme award, the Golden Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross, of which he was the only recipient.

Rudel flew a total of 2,530 combat missions and was credited with the destruction of 519 tanks, one battleship, one cruiser, one destroyer, 70 landing ships, 150 gun emplacements, 800 combat vehicles of various types, and seven airplanes. He was shot down 30 times and was wounded five times. In February 1945, his most serious injury necessitated the amputation of his lower right leg. He continued to fly missions despite orders grounding him; the Soviet vehicles he destroyed thereafter were credited to the "*geschwader* account" (i.e., to the overall unit).

On 8 May 1945, Rudel led the remaining aircraft of his unit to a U.S. airfield, where he performed a perfect ground loop on landing, shearing off his Stuka's fixed landing gear. The Americans, obviously impressed with this feat and the well-dressed girlfriends some of his pilots were carrying as passengers, did not return Rudel to the Soviets—despite a 100,000-ruble bounty on his head—but kept him in a POW camp until April 1946.

After his release Rudel joined the Focke-Wulf firm and traveled to Argentina as its representative. While in Latin America he wrote his memoirs, which had great success worldwide; he became friends with dictator Juan Perón and developed into a skilled mountain climber. He returned to Germany in the 1960s, but his right-wing associations and outspoken defense of the Third Reich made him unwelcome in the armed forces and aviation industry; he eventually became a ski instructor, despite his artificial leg. He died in 1982 of a brain hemorrhage.

Donald Caldwell

See also
German Air Force (Luftwaffe)

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Rudenko, S. I. (1904–1990)

World War II Soviet air commander. Sergei Ignatevich Rudenko was born on 20 October 1904 in Ukraine and joined the Red Air Force in 1924. In June 1941, he commanded the 31st Air Division and was one of few commanders to distinguish himself during the early months of the war, particularly during the defense of Moscow. From September 1942 until the end of the war, he commanded the 16th Air Army, which took part in the major operations of the war, including the Battles of Stalingrad and Kursk, and the capture of Berlin. Rudenko was promoted to colonel general in May 1944 and was awarded the Hero of the Soviet Union on 19 August 1944. In December 1948, he was appointed commander of airborne troops and in August 1950 was appointed commander of long-range aviation. In 1955, he was promoted to marshal of aviation, and in 1958 he was made first deputy commander in chief of the air force. Beginning in 1968 he was chief of the air force academy, retiring in 1973. He died in July 1990.

George M. Mellinger

See also
Kursk, Battle of; Stalingrad, Battle of

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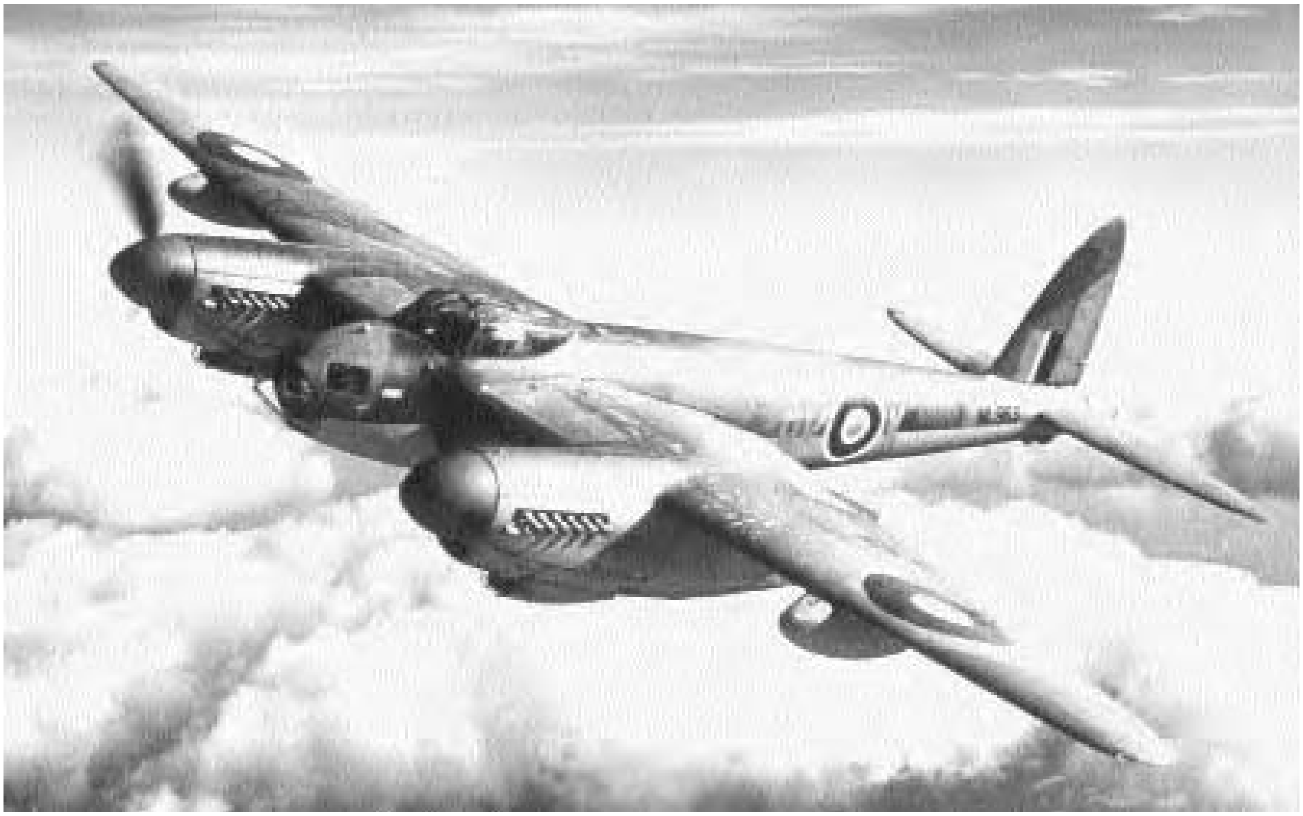
Ruhr Bombing Campaign

Allied destruction of the German industrial heartland during World War II. At the onset of war, RAF Wellington, Whitley, and Hampden bombers could carry their bombloads about 400 miles, a range that included the Ruhr River Valley. This was the location of fully 75–80 percent of German war targets. The first British raid on 15–16 May 1940 involved 93 heavy bombers. By 18 June, Britain had raided 1,666 times with six or more bombers. Included were several low-level attacks against the aqueducts of the Dortmund-Ems Canal, the sole water link between the Ruhr and eastern Germany and the North Sea and Baltic outlets. The British suffered heavy losses to the superior numbers and quality of German planes.

With the loss of France and the threat of Operation SEALION, the German code name for the planed invasion of England, raids diminished as the RAF shifted priorities to marshalling yards and barges. In December 1940, Britain shifted to nighttime bombing for two raids against Gelsenkirchen; 296 planes claimed hits, but postraid photos showed no significant damage and only a handful of craters where reports indicated there should be around 1,000.

An 8–9 March raid on Essen, the Ruhr's largest industrial city, featured the first use of Gee. Under the Gee system, three radio beams from British locations allowed navigators to pinpoint their location over the target to within one-tenth of a mile. An August 1941 report by the British Air Ministry stated that fewer than 20 percent of bombers dropped their payloads within 5 miles of their target, and a 7 November raid cost 10 percent of the 400 planes. Raids over Germany stopped until Sir Charles Portal's RAF could get the 4,000 planes, with state-of-the-art navigational and bombing aids, that Churchill promised.

Air Chief Marshal Arthur Harris assumed command of



Along with other aircraft, the Mosquito played an important role in the Allied bombing of Ruhr, Germany. (U.S. Air Force)

Bomber Command in February 1942. He switched from precision bombing to area raids using 2- and 4-ton bombs, clustered incendiaries, and marker bombs. Four-engine bombers entered the inventory, including the Short Stirling, Handley Page Halifax, and Avro Lancaster.

During the night of 6–7 March, Harris attacked Essen, the largest industrial center in the Ruhr, with 442 bombers. The bombing device called "Oboe" was used. Pathfinding Mosquito bombers dropped red and green markers for the bombers to follow. The raid set fire to an area 2 miles in diameter, with only 14 aircraft being lost. Five more attacks through July destroyed Essen and the Krupps works (locomotives, shells, fuses, guns). Raids near the Ruhr targeted Cologne and Dusseldorf. Bomber Command now had the simple H2S radar, with superior range but less reliability than Oboe. The RAF also had Mk.XIV bombsights and clustered 4-pound incendiaries.

In June 1943, the Combined Bomber Offensive began, with the RAF bombing by night and the Americans by day. A 16 May raid against the Ruhr dams at Möhne, Eder, and Sorpe cost 10 of 19 Lancasters but drowned 1,284, including Russian and German POWs and slaves. The Germans diverted hundreds of antiaircraft weapons and rebuilt the Möhne Dam, a major provider of electricity. There was no follow-up raid.

The Eighth Air Force's first major Ruhr raid was against the synthetic rubber plant at Huls on 22 June. Cost: 186 dead and more than 1,000 wounded. I. G. Farben reopened the plant within a month, and the next raid against Huls was not until March 1944. That spring, raids against petroleum targets damaged production of synthetic rubber. The offensive halted in the fall of 1943 while the Allies awaited long-range fighter support and prepared the groundwork for Operation OVERLORD by destroying the Luftwaffe and German communications that made it so effective. In February 1944, BIG WEEK defeated the Luftwaffe, and the Combined Bomber Offensive resumed against a defeated enemy air arm.

In 1944, raids continued against dams and the industrial web in the Ruhr as the Germans retreated and concentrated forces. Although the focus of the Combined Bomber Offensive was all of Germany, the Ruhr still received extensive attention. As German defenses crumbled, the Ruhr was the backup target in case of bad weather. The Allies bombed the Ruhr because it was so heavily industrialized that there was little chance of missing some valuable target or another.

Although the results of the bombing were not as dramatic as desired, they did put a cap on German production and eventually caused it to decline. In the meantime, the Germans were forced to assign a huge amount of resources in the form of personnel, radar equipment, and guns that might have been better used on the Eastern Front against the Soviet Union.

John Barnhill

See also

Avro Lancaster; Handley Page Halifax; Harris, Arthur T.

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Rumpler Aircraft

German aviation company noted for aircraft capable of high-altitude photographic reconnaissance work. German observation units used the Rumpler aircraft to great advantage throughout the last two years of World War I. Allied combat reports did not often mention the Rumpler, for the common practice among Rumpler crews was to climb to altitude over their own side of the lines before dashing over to take pictures and quickly return to safety. Most Allied pilots never encountered one.

The exception to the rule was James McCudden, the No. 56 Squadron flight commander whose 57 victories put him at the top of the Allied aces list during the first part of 1918. McCudden made a specialty of lying in wait at high altitudes to pounce on the German reconnaissance planes, and his score included several captured on the Allied side of the lines.

Rumpler's three principal products were the C.I, a general utility aircraft; the C.IV, the high-flier that established its reputation; and the C.VII, an improved version of the C.IV.

The C.VII used a Maybach MB IV six-cylinder inline 240-hp engine designed with high-altitude operations in mind, an improvement over the Mercedes used in the earlier C.IV. In consideration of their duties, Rumpler crews also served as human guinea pigs in the development of protective clothing and breathing apparatuses for aircrews, who were venturing to heights never before reached by man.

Armament for the Rumpler consisted of a synchronized Spandau gun for the pilot and a Parabellum gun mounted on a pivoting ring for the observer. Occasionally, a small bombload was also carried on external racks. So generally secure was the Rumpler from attack, however, that the pilot's gun was omitted from the Rubild, a revised version of the C.VII.

James Streckfuss

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Russian Air Force (Post-Soviet)

The Russian Air Force changed dramatically after 1991 due to the end of the Cold War and national penury. Some 6,200 Soviet combat aircraft threatened NATO in 1990, but Russia now has only 2,000 aircraft barely able to suppress Chechen guerrillas.

The air force and air defense troops merged in 1998. This created an integrated automatic command-and-control system that linked all air, air defense, antimissile, and space-defense assets and reduced staff, maintenance, and logistical burdens. All told, 580 units were disbanded, with equipment distributed among other units, and 123,500 positions were eliminated. Currently, two air armies comprising heavy bombers and transport aircraft are subordinated to the armed forces High Command. Six combined air/air defense armies, organized regionally, are subordinated to the military district commanders in Moscow, Rostov-on-Don, St. Petersburg, Yekaterinburg, Novosibirsk, and Khabarovsk.

The Russian aviation industry today struggles for survival, and long-term prospects are grim. About half of Russia's excellent aviation scientists and engineers quit in the 1990s, and few young people replaced them. Poverty forced Russia to forego new acquisitions, focusing instead on modernization, research, and marketing abroad.

Fighter modernization seeks to create multifunctional aircraft from older single-purpose designs. Mig-29, Su-27, and MiG-31 interceptors will gain new avionics, radars, and night/all-weather/inflight refueling capabilities. Armament will include new air-to-air missiles with a range of 300 kilometers, electro-optically–guided bombs, and antiradiation missiles. Modernized bombers will carry a new stealthy conventional cruise missile, reportedly with a 5,000-kilometer range.

Five fighter research programs are under way. All are multifunction aircraft, featuring thrust-vectoring engines, stealth, and supersonic cruising speeds. Two single-engine programs provide less-expensive alternatives to the two twin-engine heavy programs. The fifth program is a larger,

The name Ryan always meant quality and never more so than with the Firebee drones being carried on the versatile Lockheed C-130 transport. (U.S. Air Force)

modernized version of the MiG-29. Research has also commenced on a stealth bomber and a multirole spaceplane.

Russia was the second-largest supplier of arms to developing countries after 1991. Exports emphasized Asia, although the 1998 financial crisis limited sales. Iran, China, and India accounted for about 90 percent of revenue. Russia sold MiG-29s and Su-27s to India, Malaysia, Bangladesh, and Vietnam, Su-30s to China and India, and licensed the production of 120 Su-30s in India and 200 Su-27s in China. China bought A-50 AWACs aircraft, significantly increasing its capabilities.

Russian aircraft are rapidly aging: 48 percent are more than 15 years old, 51 percent are 5–15 years old, and 1 percent are less than 5 years old. Production dropped from 430 fighters, 40 bombers, and 120 transports in 1990 to a four-year *total* of 130 fighters, five bombers, and 12 transports from 1994 to 1997 (most were exported—Russia acquired only eight new combat aircraft in these years).

From 1991, then, overall readiness had been very poor. Lack of spare parts—particularly engines—grounded 50–70 percent of the inventory. Lack of fuel and poor serviceability prevented normal training. Pilots flew an average of 21 hours per year, compared to 200-plus hours per year in Western countries. Russia has few simulators to facilitate training, and poor flying skills caused several fatal crashes per year in recent years. Exercises emphasized long-range deployment (8,500 kilometers) of tactical aviation to troublespots, and bombers recently simulated nuclear cruise-missile attacks on North America.

Russia's near-total air superiority in Chechnya could not ensure victory and revealed seriously deficient training, equipment, logistics, and tactics. All-weather operations and air-ground coordination were particular problems. In 1994–1996, Russia flew 9,000 fixed-wing sorties, including 5,300 ground attack missions. Su-24/25s dropping unguided bombs generally failed to hit mobile Chechen units, instead causing heavy civilian casualties. Russia's second intervention in 1999 similarly emphasized Su-24/25 ground attack missions primarily with unguided bombs and fuel-air explosives.

James D. Perry

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Ryan Aircraft

U.S. aircraft manufacturer. Tubal Claude Ryan (1898–1982), fresh from flying for the Army, began a small airline and flying school in San Diego in 1922. Facilities were also used to rebuild and convert aircraft. The first original design was the M-1 high-wing monoplane (1926), of which 16 were built. The similar M-2 saw seven examples built, but by then Ryan had split with the firm and sold his portion of the airline and manufacturing firm to partner B. F. Mahoney. Shortly thereafter came the order from Charles Lindbergh for what became the Ryan NAP (New York to Paris) *Spirit of St. Louis* for his legendary transatlantic flight in May 1927.

Publicity from that flight led to the sale of some 240 Ryan Broughams. Continuing to operate his flying school, Ryan formed a second manufacturing firm in 1934, also based in San Diego. Its successful initial product was the Ryan ST (Sports Trainer) of 1934. Small orders led to the more widely produced PT-20/22 primary trainer aircraft series, of which more than 1,000 were built for use throughout World War II. The FR-1 Fireball for the Navy resulted from a 1942 specification for an aircraft with both a piston and a jet engine. The hybrid first flew in 1944, and more than 60 were built and used through 1947. This was the first U.S. Navy aircraft to have a flush-riveted fuselage exterior and metal (rather than cloth) control surfaces. One unit was rebuilt to use the first turboprop engine designed and built in the United States, but the resulting XF2R-1 Flying Shark did not enter production.

Postwar production included the Nation private business aircraft, rights to which had been purchased in 1947 and more than 1,000 of which were built. Remaining Ryan work centered on vertical-flight research aircraft, including two examples of the X-13 Vertijet that could take off straight up from a mobile trailer-launcher. Several other VTOL/STOL experimental aircraft followed, as did some 4,500 Firebee target drones. Ryan eventually retired; his firm was purchased by Teledyne in 1969.

Christopher H. Sterling

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S

Saab Aircraft

Swedish aircraft manufacturer. The 1936 call by the Swedish parliament for a more robust air force put considerable demands on the country's small and fragmented aircraft industry. One major consequence was the 2 April 1937 incorporation of Trollhattan-based Svenska Aeroplan Aktiebolaget AB. The company was restructured in March 1939 as Svenska Aeroplan Aktiebolaget Saab, becoming Sweden's primary airframe manufacturer. Although Saab designed a number of indigenous aircraft, the outbreak of World War II made it extremely difficult to produce them. Saab was not completely dormant, however, as it built a fair number of foreign aircraft under license, including those from North American, Northrop, Hawker, Gloster, and Junkers. These airplanes not only served in the Swedish air force but also were exported to Finland, where they saw combat against the Soviet Union.

By the end of World War II, Saab was committed to progressive aircraft development, especially commercial aircraft and jet fighters. The 90 Scandia was an excellent twin-engine transport, capable of carrying some 30 passengers. After the successful large-scale production of the J29 Tunnan, Saab undertook the development of a series of innovative fighter aircraft, beginning with the J32 Lansen in 1952. Like aircraft manufacturers around the world, Saab struggled with jet-engine development, and the J32 was eventually equipped with a British Avon. Still, Saab engineers were not afraid to take design risks and produced the J35 Draken, which entered service in 1959 with export versions to follow. The unique double-delta planform of the J35 established a reputation for Saab as daring, creative, innovative, and unorthodox—descriptors that apply quite well to the subsequent J37 Viggen and J39 Gripen. The 1960s and 1970s saw considerable corporate reorganization, and through mergers and acquisitions Saab now builds not only airplanes but trucks and cars. Saab's legacy is a consistent string of world-class aircraft from a neutral nation on the fringes of the Cold War.

Robert S. Hopkins

See also

Finland, and Air Operations During the "Continuation War"; Saab J-35 Draken; Swedish Air Force

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Saab J-29 Tunnan

In the years immediately after World War II, aircraft development substantially relied upon two key German advances: jet power and swept wings. Surprisingly, Western Europe's first such fighter came from neutral Sweden in the form of the J-29. Arguably little more than an engine with wings, its shape gave rise to its nickname—"Flygande Tunnan" (Flying Barrel). Proposed, planned, and approved between 1945 and 1947, the airplane reached early production during 1948, with its first flight on 1 September 1948. Initial operational deliveries went to F13 Wing in May 1951.

The airplane was quite capable and set a number of speed records. It handled well but was a challenge for pilots unaccustomed to flying a swept-wing aircraft, especially during landing. There were five variants of the J-29, including the S-29 reconnaissance version and the J-29F, equipped with afterburner, for a total of 665 aircraft. The Tunnan acquitted itself well in combat while participating in the United Nations Peacekeeping Force in the Congo from 1960 to 1963. From 1962 to 1972, the Austrian air force operated 30 former Swedish J-29s, half with photoreconnaissance capability. In May 1967, the J-29 ended its combat service with the Swedish air force but remained in use as a target tow and countermeasures trainer until August 1976.

Robert S. Hopkins

See also

Saab Aircraft; Swedish Air Force

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Widfeldt, Bo. *The Saab J-29.* London: Profile #36, 1965.

Saab J-35 Draken

One of the most unusual fighters of the 1950s. It featured a license-built Rolls-Royce Avon complete with reheat units installed in a double-delta airframe. This gave the fighter excellent handling characteristics throughout all flight regimes. In the extreme of the nose is installed a radar-tracking unit developed by Ericsson Electronics. This in turn provided guidance for a variety of air-defense missiles that included the U.S.-made Falcon and Sidewinder.

The airframe was eventually equipped with a total of nine pylons capable of carrying missiles, rockets, bombs, or, on the center-line pylons, a selection of fuel tanks. Another innovation built into the aircraft from the outset was the ability to operate from Swedish motorways.

After completing flight-testing and undergoing the usual refinements, the Draken was cleared for use by the Royal Swedish Air Force. Saab sold Draken aircraft to both Denmark and Finland. Variants included in all of these packages included fighter-bombers, trainers, and reconnaissance aircraft. Although age is slowly creeping up on the fleet, a few aircraft are still operated by Finland and Austria, which gained some second-hand examples in the 1990s.

Kev Darling

See also

Saab Aircraft; Saab J-29 Tunnan; Saab J-37 Viggen; Saab JAS-39 Gripen

Saab J-37 Viggen

Sweden's primary air defense cover for many years. Its replacement is another innovative Saab creation, the JAS-39 Gripen.

With the J-35 Draken already in service, Saab had turned its attention to the replacement that would inevitably follow. Design work had begun in 1954 with the first prototype, a canard double-delta powered by a license-built reheated Rolls-Royce Spey engine rolled out in December 1962. From the outset the Viggen was designed for operation from the country's motorways as well as normal airfields. Further innovation resulted in an aircraft that could be maintained by newly trained conscripts.

The Viggen was intended as a multirole aircraft. Weapons capability extends to missiles for air defense and antishipping roles plus bombs, rockets, and other munitions intended for ground support missions. Deliveries to the Royal Swedish Air Force—the only operator—began in the early 1970s with the interceptor version entering service first. This was followed by variants that covered training, reconnaissance, and antishipping. To cover all these vital tasks, a total of 329 machines were delivered, far less than the original projected total of more than 800.

Since the Saab Gripen entered service, the Viggen has slowly been leaving front-line service, although it should be many years yet before this most unique of shapes in the sky finally disappears.

Kev Darling

See also

Saab Aircraft; Saab J-29 Tunnan; Saab JAS-39 Gripen

Saab JAS-39 Gripen

In March 2000, four squadrons of the Saab Gripen fighter were in service with the Royal Swedish Air Force; this should reach eight squadrons (25 aircraft each) by 2004. British Aerospace and Saab collaborated to sell export models of the Gripen, which fills a niche between the Hawk 200 and the Eurofighter Typhoon.

A sophisticated swing-role single-engine lightweight fighter, the Gripen performs air superiority, attack, and reconnaissance missions. To fit the Swedish strategy of dispersed operations from highways, the Gripen takes off and lands within 800 meters. In 10 minutes a Gripen is rearmed and refueled by one technician and five conscripts.

Flying canard foreplanes and a delta wing, controlled by an electronic system, furnish excellent STOL capability, climb, and instantaneous turning rate. At low level, Gripen attains Mach 1.1 from Mach 0.5 in 30 seconds. The JAS 39 employs a reliable, low-maintenance General Electric F404–400 turbofan engine modified by Volvo to offer swift startup and high thrust. Pilot workload is minimized by an excellent display array, highly automated radar and weapons controls, and a self-contained navigation and precision-landing system.

Through an advanced datalink, Gripen shares information with other aircraft, ground forces, and ships. Real-time intelligence is immediately portrayed on the cockpit displays.

Sherwood S. Cordier

See also

Saab Aircraft; Swedish Air Force

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Safonov, Boris (1915–1942)

Soviet fighter ace. Boris Feoktistovich Safonov was born on 26 August 1915 in Sinyavino, Russia. He joined the military and completed flight school in 1934. In 1940, he was transferred to naval aviation and was assigned to a regiment flying the Polikarpov I-16 in defense of Murmansk and the Arctic convoys. During the first days of the war, Safonov was one of the few successful Soviet pilots, and by September 1941 he had scored 11 victories, being awarded the Hero of the Soviet Union (HSU) on September 16. During the winter he flew with the British pilots who brought Hawker Hurricanes to Murmansk and was awarded the British Distinguished Flying Cross. After flying the Hurricane, he converted to the Curtiss P-40 Kittyhawk.

On 30 May 1942, he was lost in action flying over convoy PQ-16. It is uncertain whether the motor of his P-40 failed or he was shot down. Though some sources credit him with as many as 34 victories, Safonov's logbook claims 20 individual and six group air victories. He was awarded a second HSU posthumously in June 1942 and became a major focus of Soviet publicity.

George M. Mellinger

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SAGE (Semiautomated Ground Environment) Defense System

Pioneering air defense computer system. In the early 1950s, the USAF still relied on manual equipment and voice communications to direct its interception of incoming aircraft. After intense competition among contractors, in 1953 the USAF placed its sole support behind the system being developed around the new Whirlwind digital computer at the Massachusetts Institute of Technology's Lincoln Laboratories.

This Lincoln Transition System, renamed SAGE in 1954, would integrate search and height-finding radars, along with other sources of information such as picket ships, early warning aircraft, and even ground observers. All of this would be processed by a central computer, which could then display on a cathode-ray tube target information to ground controllers and relay that information to other air defense facilities around the country. Air battles would be directed from eight combat operations centers and 32 interconnected SAGE direction centers distributed throughout North America. Each direction center was a massive above-ground concrete shock-resistant windowless monolith capable of supporting up to 100 individual ground controllers. In times of emergency a SAGE center could also partially assume the duties of another, presumably destroyed, center, even remotely launching surface-to-air missiles from hundreds of miles away. This was an extremely ambitious program, pushing 1950s technology to its very limit, but extensive and successful testing in 1954 dissipated much of the skepticism within the USAF surrounding the program.

Even before the first SAGE installation could become operational, however, it was threatened with obsolescence by the first Soviet ICBM tests of 1957. Though the Soviet bomber force would presumably remain a problem for years to come, missiles were obviously the threat of the future, and SAGE was solely an antiaircraft system. The program did proceed, however, and the first SAGE air defense sector became operational around New York in the summer of 1958. The following year the scale of the planned SAGE deployment was reduced, and as a result only 23 direction centers of the 32 envisioned reached operational capability (one in Canada, the rest in the United States). The SAGE system was fully operational by 1963, and it did perform as designed, vastly increasing the air defense capabilities of the continental United States. Succeeding years saw improvements such as the incorporation of direct datalinks with interceptor aircraft and a secondary system of Backup Interceptor Control stations. Still, as the 1960s progressed it became increasingly clear that the threat from Soviet bombers had largely failed to materialize and that SAGE centers were unlikely to survive an initial Soviet ICBM attack. In the early 1980s, SAGE was replaced by new Joint Surveillance System, and in 1983 the last SAGE center went offline.

Though in retrospect its mission was disappearing even as it was being deployed, the SAGE defense system left a lasting military and technological legacy. It was the first large-scale real-time computerized command-and-control system in the world, and it clearly advanced the state of the art in digital computers in the 1950s. In a less tangible but probably even more important role, SAGE also provided invaluable experience in the very new fields of large-scale hardware and especially software development. It therefore played a role in U.S. history in the twentieth century in much the same way the Erie Canal did in the nineteenth century—as the training ground for an entire generation of engineers.

David Rezelman

See also

Air Defense Command; Cold War; Distant Early Warning; North American Air Defense Command; Radar; Strategic Air Command

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Saint Mihiel, Battle of (1918)

Largest Allied air operation of World War I. General John J. Pershing planned to eliminate the Saint Mihiel salient in early September to secure the rear of the U.S. Army for its participation in a general Allied offensive later in the month to end the war. The salient was a German bulge in the French lines that had existed since 1915, measuring 24 miles across the base and 14 miles deep. Aerial photographs revealed a series of defensive lines with wire and obstacles in three belts.

Pershing's First Army conducted a converging attack on both sides of the salient to pinch off enemy forces while a French corps made a supporting attack against the salient's nose.

The first Army chief of air service, Colonel William Mitchell, coordinated the largest aggregation of air forces in a single operation during World War I to support the attack. The French, British, and Italian air forces provided units to reinforce the U.S. Air Service's 28 squadrons. The greatest contribution came from the French—a total of 58 squadrons, mostly pursuit and bombardment. Major General Hugh Trenchard's Independent Force of the Royal Air Force provided eight nighttime bombardment squadrons in support of Mitchell, but not under his direct command. The Italians provided three more nighttime bombardment squadrons for a total of 701 pursuit, 366 observation, 323 daylight bombers, and 91 nighttime bombers—adding up to 1,481 airplanes, 12 balloons, and some 30,000 men. The Germans were outnumbered in pursuit aircraft by a factor of 10.

Allied pursuit aircraft engaged the enemy over its own airfields and strafed and bombed enemy road traffic. Pilots such as Frank Luke, the famed "Arizona balloon-buster," attacked enemy balloons. Bombers attacked major road and rail junctions. Poor weather inhibited Mitchell's aerial offensive, but his strategy overwhelmed the opposing German air forces and maintained Allied air supremacy throughout the battle, contributing to its success.

Bert Frandsen

See also

Independent Bombing Force; Luke, Frank Jr.; Mitchell, William; Trenchard, Hugh

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Saint-Exupéry, Antoine de (1900–1944)

French writer and aviator. Antoine de Saint-Exupéry brought the adventure of aviation to millions. His works tell of aviation's pioneering days and swept up readers depicting men flying vast distances in brutal weather over uninhabited terrain. One of the best is *Wind, Sand, and Stars* in which Saint-Exupéry tells of his crash in the Sahara Desert and the Spanish civil war.

Drawing from these experiences he wrote the children's story *The Little Prince.* Here, a young prince arrives on earth and meets a crashed pilot, plying him with questions concerning life, happiness, adventure, and humanity. In May 1940, Saint-Exupéry, who had worked energetically to get a combat assignment, flew useless reconnaissance missions during the blitzkrieg. *Flight to Arras* tells of fighting for France's life while comprehending the fruitlessness of his efforts. Nevertheless, he risked his life to show that France remained alive. Exiled in New York, he exhorted Frenchmen to cease fighting among themselves and drive out the Germans. *Wartime Writings* related his disgust about France's divisive politics.

Once back in combat, he was shot down by the Luftwaffe on 31 July 1944. In 1998, a fisherman discovered his P-38 and ID bracelet off France's southern coast. France inscribed his name in the Pantheon and put his likeness on French currency; he remains an enduring aviation and literary legend.

Benjamin F. Jones

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Sakai, Saburo (1916–2000)

Ensign in the Imperial Japanese Navy; one of the empire's great aces. Saburo Sakai was born in the small farming village of Nishiyoka Mura in Saga Prefecture on 26 August 1916. Sakai enlisted in the navy at Sasebo naval base in May 1933. Sakai graduated and was assigned to the battleship *Kirishima.*

In June 1936, Sakai was accepted into flight training after twice flunking the entrance exam. Sakai graduated first in his flight-training class in November 1937. Sakai was then sent to China, where on his first combat mission (5 October 1938) he achieved his first aerial victory.

In October 1941, Sakai was transferred to the Tainan Air Group. As a member of that group, he participated in the Philippines and Dutch East Indies campaigns. In April 1942, Sakai's group was transferred to Rabaul, then to Lae, New Guinea. On 7 June 1942, Sakai was severely wounded by a .30-caliber bullet fired by a U.S. SBD Dauntless. Sakai made it back to his base on Rabaul but would spend a good deal of time recovering.

Upon his recovery, Sakai was transferred to the Omura Air Group and then the Yokosuka Air Group. Sakai's last mission was in June 1944, when he participated in an intercept action over Iwo Jima. Sakai's failing eyesight forced him into an instructor's role with the Yokosuka Air Group and Air Group 343.

Sakai finished the war having flown more than 200 missions, never losing a wingman and scoring 64 air victories.

David A. Pluth

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Salerno, Battle of (1943)

Air operations in support of amphibious invasion of Italy. On 9 September 1943, the U.S. Fifth Army landed at Salerno, south of Naples, in Operation AVALANCHE. The operation was supported by aircraft flying from Sicily and from four escort carriers offshore. The landing was preceded by a devastating attack on the Axis airborne complex at Foggia by U.S. heavy bombers and strafing Lockheed P-38 fighters. German forces in the area reacted quickly and launched armored counterthrusts against the beachhead that were not overcome until September 15. Much of the fighting centered around the control of the airfields of Paestum and Monte Corvino.

The Luftwaffe struck repeatedly against offshore shipping, and the battle is notable for the first use of new FX 1400 and Hs 293 glider bombs in attacks that damaged the cruisers USS *Savannah* and HMS *Uganda* and the battleship HMS *Warspite.*

As in Sicily, Allied air forces were less successful in providing close support of ground forces, and the final defeat of the German counterattacks can probably be attributed more to the effect of naval gunfire than to Allied airpower.

The invasion site of Salerno—at the limit of Allied land-based fighter cover from Sicily—shows the importance Allied planners placed on land-based air cover for amphibious operations. A landing farther north would have been more desirable for both political and military reasons had fighter cover been available.

Frank E. Watson

See also

Italian Campaign

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Salmond, John M. (1881–1968)

Marshal of the Royal Air Force. After graduating from Sandhurst and serving as an infantry office for a number of years, "Jack" Salmond transferred to the Royal Flying Corps and won his wings in 1912. He rose rapidly in rank and by the end of World War I was a major general in command of all RAF units in France.

For the decade following the war, he proved an excellent administrator and especially distinguished himself as commander of the British forces in Iraq in 1922, when he dealt with a Turkish invasion and Kurdish uprising.

In 1929, Salmond was named Chief of Air Staff at a most difficult time. The Depression, as well as the Geneva disarmament conference that opened 1932, led the British government to seek deep cuts in the defense budget, especially the RAF. Thanks largely to the intransigence of Germany and France, the talks collapsed and the RAF was spared.

Salmond retired in 1933 but remained active in air matters, both military and commercial, for the remainder of his life.

Phillip S. Meilinger

See also

Royal Flying Corps/Royal Naval Air Service/Royal Air Force; "Ten-Year Rule"; Trenchard, Hugh

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Salmson Aircraft

Early French engine and aircraft manufacturer. The Société des Moteurs Salmson, like many other World War I engine manufacturers, elected to also try its hand at the design and production of aircraft to accompany its engines. In 1916, its first attempt—the Salmson Moineau—was built around a design by the prewar French aviator Raymond Moineau.

Its most successful product, however, was the famous Salmson 2A2, which equipped some 55 French reconnaissance escadrilles and, in the summer of 1918, another 11 squadrons of the U.S. Air Service. Examples were also used by faraway air services like Russia's and Japan's.

Powered by the 230-hp Salmson 9Za nine-cylinder rotary, the aircraft was a two-bay biplane with equal-span wings and a single Vickers .303-caliber machine gun equipped with an interrupter gear to allow firing through the propeller arc. Strong and fast, the 2A2 could climb to 5,000 meters in less than half an hour and cruise at that altitude at 168 kph. There was no finer Allied reconnaissance aircraft produced during World War I.

Further variants numbering through the Salmson 7 were attempted, but only 20 examples of the last numbered version were built, and the rest seem to have not made it beyond the prototype stage. In the postwar years Salmson introduced only a few new designs and became part of CFA in 1936.

James Streckfuss

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Salyut

The world's first space station. In 1971, the Soviet Union launched Salyut in honor of the tenth anniversary of Yuri Gagarin's historic spaceflight. Launched by a Proton rocket, the 45-foot, 40,000-pound Salyut consisted of four different cylinders containing equipment, experiments, and a propulsion system. After the Soyuz arrived at Salyut 's front docking port, the crew transferred through a hatch into the station's three work compartments: a small work compartment, the frustum, and a large work compartment. Seven workstations controlled Salyut, and designers took advantage of three dimensions by installing the scientific equipment on all compartments' surfaces that were different colors for crew orientation. Other amenities included a dining table and sleeping bags. A hygiene station, encased in washable material to retard bacteria growth, was located at the back of the large compartment.

The first three successful cosmonauts on Soyuz 11 completed 24 days of experiments and public television programs, then deorbited only to be killed by an open valve that depressurized the spacecraft. Next, the Soviet military began a space station program, but its first craft, Salyut 2, failed. The Salyut 3 and Salyut 5 crews successfully occupied the stations that were smaller than their civilian counterparts, had rear docking ports, used encrypted communications, and flew much closer to the earth. Attached to the front of the station was a film-return capsule. A civilian craft, Salyut 4, had three steerable solar arrays, a hatch with an extravehicular activity airlock, and many new experiments. Two crews successfully occupied the station for 92 days.

Two docking ports enabled Salyut 6 crews to use an unmanned space freighter, Progress, to resupply the station with food, water, and fuel. Additions to the large work compartment included a telescope, a gamma radiation detector, and the new docking port that permitted fuel transfer from the Progress to a modified propulsion system. Eighteen crews accomplished missions on Salyut 6, and 12 Progress spacecraft automatically docked. Salyut 7 incorporated electric stoves, hot water, refrigerators, experimental furnaces, and improved medical facilities while two new portholes allowed limited ultraviolet radiation to kill microorganisms and mold. In February 1985, Soviet mission controllers lost control of Salyut 7, and a repair crew was launched to the tumbling vehicle. The cosmonauts docked, reactivated the frozen systems, and revived the station. Twelve crews and 12 Progress spacecraft successfully occupied Salyut 7 until May 1986, when Mir began spaceflight missions, thus terminating the Salyut program.

John F. Graham

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Samson, Charles R. (1883–1931)

Royal Air Force air commodore. Samson, born on 8 July 1883 in Manchester, entered service on HMS *Britannia* in 1896. In 1911, Samson was among four naval officers selected for flying training. He undertook the navy's first experimental flights from ships, flying off the anchored battleship *Africa* on 10 January 1912 and *Hibernia* on 9 May while it steamed at full speed. When the Royal Flying Corps formed in 1912, he took command of the naval wing and led development of aerial wireless communication, bomb- and torpedo-dropping, navigation, and night-flying.

When war came in 1914, Samson took the Eastchurch Squadron to France. It supported Allied ground forces along the coast with aircraft and improvised armored vehicles and conducted several successful attacks on German Zeppelin sheds. The unit transferred to the Dardanelles in March 1915 to provide air cover during the unsuccessful Gallipoli campaign, after which it disbanded. Samson then commanded a seaplane carrier squadron that ranged throughout the eastern Mediterranean, reconnoitering and attacking Turkish positions.

From March 1917 until the end of hostilities, Samson commanded the Great Yarmouth Air Station, which controlled North Sea antisubmarine and anti-Zeppelin air operations.

Samson resigned his naval commission in August 1919, becoming a group captain in the new Royal Air Force. He was appointed air officer commanding (Mediterranean) in 1921 and then commanded the Kenley fighter group (1922–1926). As chief staff officer, Middle East Command, until August 1927, he organized and led the first bomber formation flight from Cairo to Capetown.

Samson resigned his commission in 1929 and died at Cholderton, Wiltshire, on 5 February 1931.

Paul E. Fontenoy

See also
Fleet Air Arm; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Sueter, Murray

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Santa Cruz, Battle of (1942)

Air operations in support of carrier engagement during the Guadalcanal campaign. Covering a land offensive on Guadalcanal, the Japanese Combined Fleet sortied east of the Solomons with the carriers *Shokaku, Zuikaku,* and *Junyo* and the light carrier *Zuiho.* A U.S. task force based on carriers *Enterprise* and *Hornet* engaged.

On the morning of 26 October, scout planes from *Enterprise* located and damaged the light carrier *Zuiho.* Both sides soon detected each other's main force and launched major strikes that passed each other on the way to their targets. The U.S. strike badly damaged the carrier *Shokaku* and cruiser *Chikuma* while the Japanese strike was setting *Hornet* afire. *Hornet* was abandoned, then sunk by Japanese destroyers shortly after.

The battle continued the attrition of naval aircraft and pilots, which the Japanese could ill afford after the cumulative losses of this and previous battles. The Japanese carrier force would not seriously oppose U.S. moves until the invasion of the Marianas, more than a year and a half later.

Santa Cruz provides the best example of the simultaneous strike of two offensive air groups against each other's base. Tactically, the valuable defensive performance of *South Dakota* against Japanese air attacks proved the worth of the newly installed heavy antiaircraft armament on U.S. battleships.

Frank E. Watson

See also
Guadalcanal

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Saro Aircraft

British aircraft manufacturer. More properly known as Saunders Roe, the Saro firm came into existence in 1928 when Alliott Verdon Roe moved over from the Avro firm. Joining with John Lord, they acquired the small firm of S. E. Saunders, which had already built a series of small amphibians.

The new Saro firm produced some amphibians for the civilian market before building the London sea-biplane for the RAF, followed by the Lerwick seaplane for Coastal Command, both operating in the patrol role.

During the early years of the jet age, the company created the Saro SR.AI1 jet fighter and the enormous Princess flying boat that featured coupled turbines as its power plants.

A switch to the production of small helicopters began in 1951 with the Skeeter for the British army. Its last venture was the Saro PSI, which eventually became the Wasp after the company was taken over by Westland.

Kev Darling

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Satellite Command and Control

Without satellite command and control, there would have been no verifiable space firsts. Beginning with the earliest satellite developments, engineers understood the need for a satellite command-and-control segment to monitor and gather data from their satellites. The U.S. government selected the Vanguard program for the first civilian space project in part because it included plans for a space-to-ground communications segment. The earliest military satellite programs also included a ground segment that was not at all related to the civilian program.

Artificial satellites are orbited for many reasons. Some are used as very-high-altitude reflectors, passive or active, of signals sent from the earth and received again on earth. Others spend time in space and then are recovered, dropping back to earth with information, instruments, or a crew that has accomplished a space mission. In many other cases, information that is collected, either about space itself or the earth, which a satellite is observing, is transmitted back for use on earth. These radio connections between earth and space are the primary reasons for orbiting satellites into their lonely paths, hundreds or thousands of miles above the earth.

Communications, command and control, as well as the satellites themselves are basic elements in a complete space system. The satellite may send back data obtained from its sensors, information regarding the "health" of its subsystems, or responses to questions sent from earth. An earth station can receive the data transmitted, give commands (such as transfer to a redundant subsystem), change velocity vector, determine the satellite orbit, and ask questions. Ground tracking stations and an integrated command-and-control system are essential for any space mission. The tracking stations can control and obtain information from the satellites only while they are within sight of the ground antennas.

One element of the CORONA program, America's first spy satellite, was designed to demonstrate U.S. Air Force capabilities for the launch, stabilization, control, and recovery of instrumented capsules from orbit. Ground tracking stations and an integrated command-and-control system were essential for such a program. By the end of 1958, these stations were installed and checked out, ready for the first CORONA launch in early 1959. During May and June 1959, CORONA was divided into three distinct satellite programs, and the command-and-control function was separately identified. This function consisted of a control center, called the Satellite Test Center (STC), a number of Remote Tracking Stations, and all the equipment and software required to track and control satellites during ascent, on-orbit, and recovery from space operations. The STC was located near the Lockheed facility in Sunnyvale, California. NASA satellites are largely controlled from the Goddard Space Flight Center in Greenbelt, Maryland, using the Deep Space Network.

Fundamentally, any satellite control network is a service organization, providing critical contact between humans on the ground and robots hurtling through space. A satellite control network controls, in real time, multisatellite on-orbit space vehicle operations, 24 hours a day, 7 days a week.

David C. Arnold

See also

National Aeronautics and Space Administration; Satellites; SENTRY (Samos) Reconnaissance System; Space Shuttle, and Military Use

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Satellites

Man-made objects orbiting the earth or other celestial bodies. The theoretical and experimental groundwork for building, launching, and employing satellites began during the late nineteenth century and continued well into the twentieth century. Three individuals, all inspired by the science fiction of Jules Verne (1828–1905) and H. G. Wells (1866–1946), were especially prominent in developing scientific theories of space flight: Konstantin Tsiolkovsky (1857–1935) in Russia; Robert Goddard (1882–1945) in the United States; and Hermann Oberth (1894–1989) in Germany. Inspired by these theories, such prominent engineers as Sergei Korolyov (1906–1966) in Russia, Wernher von Braun (1912–1977) in Germany and the United States, and Hsueshen Tsien (1911–) in the United States and China spearheaded creation of the launch vehicles and space programs needed to make satellites possible. On 25 May 1945, Arthur C. Clarke (author of *2001: A Space Odyssey*) presented to the British Interplanetary Society a memorandum detailing the principles of communications satellites in geostationary orbit 22,300 miles above the earth. This—the first serious proposal for a satellite application—reached a wider audience through publication in the October 1945 issue of *Wireless World* magazine.

During the decade following the end of World War II, several studies sponsored by defense organizations pointed to the feasibility of launching satellites for various purposes. The U.S. Navy's Bureau of Aeronautics issued a report in November 1945 that said a "space ship" orbiting above the earth might enhance our knowledge of science, communications, and meteorology. With or without humans aboard, it could perform reconnaissance of enemy positions, deliver explosive charges, or intercept and combat enemy craft of a similar type. Not long thereafter, in May 1946, engineers from Douglas Aircraft Company's Project RAND presented the U.S. Army Air Forces with a 250-page report titled "Preliminary Design of an Experimental World-Circling Spaceship." According to that report, the United States could construct and launch a "satellite vehicle" in approximately 5 years at a cost of $150 million. It pointed to such uses as reconnaissance, weapons delivery, meteorology, scientific research, and communications, as well as journeys beyond earth orbit.

In the Soviet Union, as early as 1947 Mikhail Tikhonravov began contemplating the use of multistage rockets to launch satellites. He formally presented a seminal paper on the potential uses of satellites to a special session of the Soviet Union's Academy of Artillery Sciences on 15 March 1950. Finally, in March 1954 James Lipp and Robert Salter completed RAND's two-volume *Project Feed Back Summary Report* for the USAF. Although focused primarily on high-resolution reconnaissance from space, their assessment added navigation to the list of previously identified satellite applications.

Even as the United States and Soviet Union secretly proceeded with plans to develop satellites for reconnaissance and other defense-related applications, civilian experts openly proposed using them for peaceful scientific research during the upcoming international geophysical year (July 1957–December 1958).

At the fourth Congress of the International Astronautical Federation in Zurich, Switzerland, in 1953, University of Maryland physicist S. Fred Singer drew from an earlier study by several BIS members and proposed the Minimum Orbital Unmanned Satellite of the Earth (going by the acronym MOUSE). The following year, von Braun's team from the U.S. Army's Redstone Arsenal and members of the Office of Naval Research (ONR) joined ranks to propose Orbiter, a small scientific satellite. On 15 July 1955, President Dwight Eisenhower announced that the United States planned to launch an Orbiter-type satellite using a modified military Jupiter-C rocket. Shortly thereafter, it was decided that America's first satellite attempt would be made using a civilian launcher under Project Vanguard.

Meanwhile, the Soviet Union's Korolev and Tikhonravov pressed their government to support ongoing efforts to beat the United States into space. On 4 October 1957, the Soviet Union launched the world's first satellite—Sputnik 1—carrying only a simple radio transmitter. The Soviet Union launched a second satellite, which carried a canine passenger, the following month. After failing in its initial attempt to launch a Vanguard satellite in December 1957, the United States successfully sent Explorer 1 into orbit on 31 January 1958 and, using onboard instrumentation, discovered the Van Allen radiation belts.

Meanwhile, the U.S. defense establishment proceeded with plans for military satellites. On 27 November 1954, the USAF Air Research and Development Command issued the first formal requirement for a reconnaissance satellite. Actual development of the advanced satellite system, designated Weapon System (WS)-117L, commenced in October 1956 with the award of a contract, under the project name Pied Piper, to Lockheed Aircraft Corporation. Sometime between early December 1957 and the end of March 1958, it was decided that the photographic subsystem offering the best prospect for early success—recoverable film capsules—would be split off from WS-117L, placed under joint CIA-USAF management, and designated Project CORONA. To defuse widespread public speculation about spy satellites and to conceal CORONA's real purpose, a press release on 3 December 1958 announced the initiation of a technology-demonstration and biomedical-experimentation series called Discoverer. A second, more sophisticated photographic reconnaissance capability—direct read-out from space—was dubbed Sentry and, later, Samos. The original WS-117L program's remaining subsystem, which involved space-based detection of potentially hostile long-range missile launches, was renamed Midas—the Missile Defense Alarm System. Discoverer 1, launched from Vandenberg AFB, California, on 28 February 1959, became the world's first polar-orbiting satellite. The first recovery of an object from orbit occurred with the launch of Discoverer 13 on 10 August 1960 and the ejection of its capsule, which was snagged from the Pacific Ocean. Just a week later, the Discoverer 14 launch resulted in the first midair recovery of a space capsule—one containing film footage of Soviet military sites.

America's development of prototype and first-generation satellites for a variety of civil and military purposes—meteorology, navigation, communications, missile warning, and nuclear detection—flourished during the 1960s. NASA, which was established in 1958 to handle U.S. civil space activities, sent the world's first weather satellite—Tiros 1—into orbit on 1 April 1960. Unique requirements associated with Samos and certain other national security satellite operations led to the USAF launching, on 23 August 1962, of the world's first military satellite for weather observation—forerunner to the Defense Meteorological Satellite Program (DMSP). On 13 April 1960, the U.S. Navy's Transit 1B became the world's first navigation satellite. That service's GRAB 1—the world's first electronic intelligence (ELINT) satellite, known originally as Solrad 1—hitched a ride into space with the third Transit on 22 June. With the launches of NASA's Echo 1 on 12 August 1960 and the Army's Courier 1B on 4 October 1960, the U.S. fielded, respectively, the first passive and active-repeater communications satellites. Syncom 2, another NASA communications satellite, became the world's first geosynchronous satellite on 26 July 1963. A dedicated military capability emerged on 16 June 1966 when the USAF launched a cluster of seven satellites in what later became the Initial Defense Satellite Communications System (IDSCS).

Midas satellites during the 1960s paved the way for the fully operational Defense Support Program (DSP) missile-warning satellites of the 1970s. The first pair of Vela nuclear detection satellites on 17 October 1963 gave the United States oversight of Soviet compliance with the Limited Nuclear Test Ban Treaty. By 1970, the United States led the rest of the world in satellite applications.

If the United States outdistanced the Soviet Union in the realm of satellite types, the Soviet Union assumed an overwhelming lead in terms of the sheer number of satellites launched and did not lag far behind in developing an equally diverse range of applications. The Soviets began their space-based photographic reconnaissance missions in 1962 and meteorological satellite program in 1964. With the launch of Meteor 1 on 26 March 1969, the Soviet Union initiated a single integrated space-based network to meet both civil and military needs. That, incidentally, was something the United States did not attempt until 1998, when the USAF transferred DMSP to the National Oceanic and Atmospheric Administration. The Molniya 1-1 launch on 23 April 1965 gave the Soviet Union its first communications satellite. Kosmos 192, patterned after the U.S. Transit network and launched on 23 November 1967, became that nation's prototype navigation satellite. The Soviets also achieved a space-based ELINT capability in 1967. Not until Kosmos 520 in September 1972 did they have a space-based missile-warning capability. By the turn of the century, Russia had launched more than twice as many satellites as the United States and all other countries combined.

Several nations sought to join the United States and Russia by independently launching their own satellites. France became the world's third space power with its launch of Asterix in 1965. It established a high-resolution imaging capability with SPOT 1 in 1986 and an ELINT capacity with Helios 1A in 1995. Australia entered the ranks in 1967 with its launch of the Weapons Research Establishment Satellite (Wresat 1), as did the United Kingdom with Prospero in 1971, but these were the only successful independent launch attempts by those nations. China and Japan became space powers in 1970 with their launches, respectively, of Dong Fang Hong-1 and Osumi. China subsequently deployed its own recoverable photographic reconnaissance satellite system (1975), a geosynchronous communications satellite (1984), an experimental meteorological satellite (1988), and a navigation positioning satellite (2000). Japan also put up its first experimental communications satellite (1975), a meteorological spacecraft (1977), and geodetic payload (1986). Established officially in 1975 with 11 member nations, the European Space Agency succeeded in using its Ariane 1 booster to launch test equipment in 1981 and telecommunications satellites in 1984. India launched its first domestically produced satellite—Rohini 1—in 1980 using a Russian booster and became a full-fledged space power in 1997 with the launch of an earth-imaging satellite atop its own domestically produced launch vehicle. Not to be excluded, Israel used its Shavit rocket to launch its own Offeq-1 experimental satellite in 1988. Others developed their own satellites but relied on the space powers for launch services.

Although satellites obviously performed numerous peaceful functions and provided the military superpowers with unprecedented strategic capabilities during the Cold War, reliance on space-based platforms during actual hostilities was slow to develop. In October 1962, weather pictures of the Caribbean returned by the first DMSP satellite enhanced the effectiveness of aerial reconnaissance missions over suspected Soviet missile batteries in Cuba. Use of DMSP satellites during the Vietnam War (1963–1975) allowed cancellation of tactical weather reconnaissance flights and thereby kept American pilots out of harm's way. The USAF also used two NASA Syncom satellites, as well as its own IDSCS constellation, for voice communications and transmission of digitized photographic intelligence from Southeast Asia back to the United States. The latter permitted more timely analysis and, consequently, quicker decisionmaking with respect to war plans. During the Yom Kippur War of 1973, U.S. satellites verified Egyptian noncompliance with the cease-fire agreement. U.S. DSP satellites detected missile exchanges during the Iran-Iraq War (1980–1988). Communications satellites played a major role in British operations during the Falkland Islands War of 1982, America's Operation URGENT FURY in Granada in 1983, and Operation JUST CAUSE in Panama during 1989–1990. Field commanders of all services gradually began to acknowledge that space-based systems provided significant strategic, tactical, and operational advantages on the battlefields of the late twentieth century.

Not until Operations DESERT SHIELD/DESERT STORM (1990–1991) in the Persian Gulf, however, did the United States apply the full range of space-based capabilities in theater operations. Allied forces used more than 60 military satellites, plus others from the civil and commercial sectors. More than 90 percent of all communications to and from the area passed over satellite links, with daily traffic at the height of operations climbing to 700,000 voice calls and 152,000 digital messages. Full-time television usage of satellite channels increased from two to 22, with short-time usage peaking at more than 400 channels one day in January 1991. Imaging satellites, such as America's multispectral Landsat and France's extremely high-resolution SPOT, facilitated the preparation and timely updating of detailed battlefield maps. Data from DMSP and civil meteorological satellites helped optimize the application of airpower by allowing planners to shift targets, types of aircraft, and kinds of weapons quickly in response to harsh, rapidly changing weather conditions.

Although the full 24-satellite NAVSTAR Global Positioning System (GPS) would not be completed until 1994, the existing 16-satellite constellation greatly assisted Coalition forces in determining their position and coordinating troop movements across the trackless desert. The value of GPS in precision bombing also became evident. Finally, DSP satellites detected Iraqi SCUD missile launches against Israel, Saudi Arabia, and Kuwait, thereby allowing command centers in Colorado Springs, Colorado, to alert forces halfway around the globe. All of this led then USAF Chief of Staff General Merrill McPeak to label it "the first space war" and Lieutenant General Thomas S. Moorman Jr., then commander of Air Force Space Command, to describe it as "a glimpse into the future" of warfare.

At the turn of the century, U.S. military forces contemplated even greater reliance on satellite systems. The USAF established the Space Warfare Center in 1993 and the Space Battlelab in 1997 to generate improved support to war fighters. In 1994, the USAF launched the most secure, survivable satellite ever built—Milstar 1—and even before controllers had completed on-orbit checkout, the military used it for critical communications during operations in Haiti. Planners looked toward purchasing additional communications capacity from commercial providers and buying 1m-resolution imagery from a Colorado company flying the Ikonos satellite. To improve missile warning and, potentially, play a crucial role in ballistic missile defense, the United States undertook procurement of the extremely complex Space-Based Infrared System to augment and, eventually, replace DSP. The USAF sponsored development of the Space Maneuver Vehicle, which would make it easier to position payloads over specific hot spots at specific times, and it advocated fielding a space-based radar system to track and identify targets in all operating media—space, air, land, and water. Cognizant of shrinking budgets and the adage that there is strength in numbers, the military services and intelligence organizations began studying less-expensive microsatellites that would allow broader coverage of the earth, greater survivability, and easier replacement if damaged or attacked. Given the presence of some 2,700-plus satellites in earth orbit, any thoughtful observer could clearly see the growing importance of space to the well-being of all humankind.

Rick W. Sturdevant

See also

Defense Support Program, and Missile Detection; NAVSTAR Global Positioning System

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Schmid, Josef (1901–1956)

An officer of the Luftwaffe General Staff; known today for his miscalculations as head of Abteilung 5 (No. 5 Intelligence Section) in 1940. His consistent underestimation of the combat strength of RAF Fighter Command and failure to identify profitable targets were two of the principal reasons the Luftwaffe lost the Battle of Britain.

In 1935, "Beppo" Schmid transferred from the German army into the Luftwaffe. Unlike many promising staff officers who made this move, Schmid never became a pilot. After a number of staff postings in Berlin, he was given command of the Hermann Goering (Luftwaffe) Armored

Division in Tunisia, where he won the Knight's Cross of the Iron Cross. He was evacuated before the May 1943 Axis surrender in North Africa and replaced J. Kammhuber as commander of the XII Fliegerkorps (Air Corps), which contained all of the night-fighters defending Germany.

He proved to be a quick study and immediately took the measures necessary to restore his command's effectiveness. The XII Fliegerkorps was later renamed the I Jagdkorps (Fighter Corps) and was expanded to include all of the day and night-fighters of the Reichsluftverteidigung (Air Defense of Germany). Schmid's pleas to the Luftwaffe High Command to strengthen and reorganize the Luftwaffe fighter arm led to a strong and lasting relationship with Adolf Galland, a man with whom he otherwise had little in common. In December 1944, he was given command of Luftwaffenkommando West (Air Force Command West), which comprised the air units supporting the army on the Western Front. He ended the war in this post, with the rank of major general. After the war he was a principal author of the USAF historical studies on the German air force.

Donald Caldwell

See also

German Air Force (Luftwaffe); Germany, and World War II Air Battles

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Schnaufer, Heinz-Wolfgang (1922–1950)

Luftwaffe major; the world's highest-scoring night-fighter pilot. Schnaufer joined the Luftwaffe as an officer candidate in late 1939 and completed flight training in 1941. While training in the Bf 110 he teamed up with an aircrewman, Fritz Rumpelhardt, who remained with him as his radio and radar operator until the end of the war. The pair volunteered to join the new night-fighter force and were posted in November 1941 to Nachtjagdgeschwader 1 (NJG 1; 1st Night-Fighter Wing). Schnaufer and Rumpelhardt began shooting down RAF night bombers with regularity from mid-1942. Their score increased steadily. In late 1944, Hitler awarded Schnaufer the Oak Leaves with Swords and Diamonds to the Knight's Cross of the Iron Cross for his 100 nighttime victories. At year's end Schnaufer was promoted to major and given command of NJG 4. His greatest success came on the night of 21–22 February 1945, when he shot down nine bombers in two missions. By V-E Day Schnaufer's score stood at 121.

Schnaufer took over his family's successful wine business after the war, and in 1950 he was in France on a wine-purchasing trip when his convertible sportscar collided with a truck. Gas cylinders fell off the truck and struck Schnaufer, killing him.

See also

German Air Force (Luftwaffe); Germany, and World War II Air Battles

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Schriever, Bernard A. "Bennie" (1910–)

The father of the USAF ballistic missiles program; managed a technical and industrial revolution of enormous scale and scope with unprecedented success.

The difficulties in creating an ICBM ranged from building a rocket able to carry the huge warheads then thought to be required, along with such problems as guidance and control, engine staging, reentry, and so on. Early estimates indicated that the Atlas rocket being designed by Convair would have to weigh 440,000 pounds to be able to carry a thermonuclear warhead.

A breakthrough occurred in 1953, when Edward Teller and John von Neumann independently concluded that a thermonuclear warhead weighing only 1,500 pounds was feasible. A high-level board of scientists (the so-called Teapot Committee) recommended that the Atlas rocket be developed to carry the new lightweight high-yield warhead, and Brigadier General Bernard Schriever was picked to head the Western Development Division (WDD), the office charged with its development.

Schriever was the right man at the right time, for he possessed rapport with the scientific, military, and industrial communities and was able to weld them into an efficient team. The ICBM was given top priority within the Air Force, and Schriever began an entirely new management style, using the WDD as a military integrating facility for the combined efforts of science and industry.

The organization Schriever headed eclipsed the Manhattan Project in terms of scientific difficulty, budget, and, most important, urgency. Had the Manhattan Project failed, the outcome of the war against Japan would have been the same. There was no chance that Japan could have developed an atomic bomb and delivered it on the United States. In stark

One of the most important leaders in U.S. Air Force history, Benny Schriever was responsible for fielding the U.S. intercontinental ballistic missile fleet and in doing so laid the foundation for U.S. efforts in space. (U.S. Air Force)

contrast, the Soviet Union was more advanced than the United States in rocketry, and it had developed atomic as well as hydrogen bombs. If Schriever and his team had failed, the United States would have been at the mercy of a nuclear ICBM–equipped adversary.

Fortunately, Schriever elicited almost miraculous achievements from the military-scientific-industrial organization, fielding no less than three operational ICBM systems and one IRBM system in less than eight years. These included the Atlas, Titan, and Minuteman ICBMs and the Thor IRBM. And as Schriever often stated at the time, the ICBM experience paved the way to the exploitation of space. The modern network of intelligence, meteorological, communications, and navigation satellites owes its existence to the brilliant work of Schriever and his team.

Walter J. Boyne

See also
Missiles, Intercontinental Ballistic
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Schütte, Johann (1873–1940)

Born near Oldenburg to a royal administrator, Johann Heinrich Karl Schütte first studied ship engineering at the technical institute in Berlin-Charlottenburg, after which he went to work for the northern German Lloyd shipping firm. There he tested optimal hydrodynamic shapes, developing a degree of knowledge that made him famous in ship design. He was promptly offered a chair in ship design at a newly opened technical institute in Danzig in 1904. There, he began expanding his interest in other technologies. The heavy media coverage of the crash of Count Zeppelin's LZ-4 airship in August 1908 prompted Schütte to analyze the causes of the failure. Schütte wrote Zeppelin's engineering department and offered suggestions for improvement, which included strengthening the keel, improving the vertical and horizontal stabilizers, and better placement of the engines and propellers. He got no response.

Schütte then sought to build his own airship project and obtained the assistance of industrialist Karl Lanz (1873–1921). Together, they established the Schütte-Lanz (SL) airship factory at Rheinau in 1909, where the first project, SL-1, flew in 1911. It was delivered to the German army late the following year but was destroyed by a storm while anchored at mast in July 1913. Meanwhile, Schütte went about improving his designs for airship orders by the army and navy. Both services saw advantages in his solution, and the German navy used his improvements to put pressure on the Zeppelin firm to do the same with its own machines.

Schütte, for example, had devised enclosed cabins to protect the crew, placed engines in the center of the ship rather than on the side, and designed cruciform rudders, based on shipbuilding experience, that turned out to be the ideal solution for proper steering. The disadvantage of Schütte's solution involved the use of wood in the rigid structure of his ships. Initially, wood helped take care of many stress problems, as its material dynamics were better known than those of aluminum, which Zeppelin was using.

As the size of airships grew, however, and their intended functions increased, wood showed its limits, not least because of how humidity affected its tensile strength. Nonetheless, the patents that Schütte had acquired were of such importance that the German army actually requisitioned and transferred them to the Zeppelin firm for application in its war dirigibles starting in 1914. The twenty-second and last SL airship, with a capacity of 56,300 cubic meters and more than 600 feet long, was delivered in 1913 to the German navy.

Several SL dirigibles saw service during the war, by which time the general public simply referred to any airship as a "Zeppelin." When asked about this, Schütte stated that he bore no grudge. After the war, however, hoping to restart his operations, he sued Zeppelin in court over the patents and lost. Projects he had kept handy for a transatlantic airship as well as one to fly to the Arctic led nowhere, as Schütte failed to find financial support in the United States for his ideas.

Out of luck and out of funds, the SL firm closed in 1925. Although Johann Schütte deserves high praise for his initial designs, credit also goes to several SL engineers who put such ideas into practice. After the end of SL, Schütte remained active in aeronautics, teaching in Berlin and heading the German Aeronautical Science Society until its dissolution on orders of the Nazis in 1935. Schütte retired from teaching three years later.

Guillaume de Syon

See also

Airships; Zeppelin, Ferdinand von

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Schwarzkopf, H. Norman (1934–)

Overall commander of U.S., British, and French military forces in the Kuwaiti Theater of Operations during the Gulf War.

Born in Trenton, New Jersey, Schwarzkopf graduated from the U.S. Military Academy in 1956. A much-decorated veteran of numerous military assignments, including two tours of duty in Vietnam, he first attained the rank of general in 1978 and in October 1983 was deputy commander of U.S. forces in the invasion of Grenada.

In 1988, he was appointed to head U.S. Central Command. After Iraq invaded Kuwait in August 1990, he was responsible for planning and executing Operations DESERT SHIELD/DESERT STORM. Along with Saudi Arabian Lieutenant General Khalid Bin Sultan, the commander of the Arab/Islamic Joint Forces Command, with whom he established a combined headquarters, Schwarzkopf was responsible for the conduct of air, land, and sea campaign against Iraqi military forces. After extensive air and naval operations that set the stage, Schwarzkopf directed a turning movement by the U.S. VII and XVIII Corps that enveloped the Iraqi defenses. In 100 hours, the ground operation was over, the Coalition's objective of forcing the Iraqis from Kuwait achieved.

Schwarzkopf relinquished command of Central Command on 9 August 1991 and retired from active duty on 31 August of that year. He remains active in public affairs as a noted speaker.

James H. Willbanks

See also

AirLand Battle; DESERT SHIELD; DESERT STORM; Horner, Charles A.; Jointness

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Schweinfurt-Regensburg Raids

Part of the Combined Bomber Offensive initiated by a 10 June 1943 Combined Chiefs of Staff directive. On 17 August, the first anniversary of the U.S. Eighth Air Force's initial raid at Rouen, Major General Ira Eaker sent his bombers on their deepest penetration raid. The 3d Bombardment Division was to attack Regensburg and the 1st Bombardment Division Schweinfurt. Regensburg was 500 miles from England, Schweinfurt 400 miles. Such distances allowed the Luftwaffe to deploy all its defenses.

Plans called for the 1st Bombardment Division to hit Schweinfurt 10 minutes after the 3d Bombardment Division hit Regensburg, with the 3d returning over the Alps to Tunisia and the 1st returning the way it came. Fighter support extended less than halfway to the targets, as most escorts did not have long-range drop tanks.

Early-morning fog on 17 August forced a change in plans. While the 3d departed at about 6:30 A.M., the 1st was delayed 5 hours. German coastal monitoring stations picked up the formations at 17,000 feet. The first fighters attacked over Belgium. Of the 3d's 146 B-17s, 122 reached the target and dropped 250 tons of bombs.

The 1st's delay allowed German fighters time to refuel and hit them hard. The 1st struck four hours after the 3d, returning through a gauntlet of fighters. Only 184 of the original 230 bombers dropped 380 tons on Schweinfurt. Ten were forced to abort due to mechanical problems. Of the total of 376 B-17s, 60 (24 over Regensburg and 36 over Schweinfurt) were lost to enemy action. Of the 306 that returned from the mission, more than 25 percent were heavily damaged. They lost 601 airmen killed, wounded, or captured. The Regensburg loss rate was 16.4 percent, Schweinfurt 15.7 percent. The Germans acknowledged 25 fighters lost; U.S. crews claimed more than 100.

Although bombing accuracy was excellent and most primary buildings were damaged at Regensburg, few of the machine tools were destroyed, and they were back in production in four weeks. According to the German armaments minister, Albert Speer, the Regensburg raid sped up German plans to disperse parts production to hard-to-bomb shops in nearby villages and towns. Initial German estimates put August-September fighter production losses at 800. Unknown, however, was the fact that the raid destroyed new fuselage jigs for the Me 262 jet fighter. German managers later speculated that this delayed jet production by a critical four months. At Schweinfurt, ball-bearing production suffered a 38 percent decline. However, by October overall production had actually increased.

In spite of criticism of U.S. tactics, the mixed success of the raids had less to do with flaws in strategic bombing doctrine and more to do with the inability of the 500- and 1,000-pound bombs to fully destroy the machine tools.

On 14 October, with ball-bearing production restored, a second Schweinfurt raid was attempted. Black Thursday, as it became known to history, cost the USAAF 60 of 291 aircraft and more than 600 men. The raid cut production 67 percent. After the war, Speer expressed surprise that the Allies had not sent follow-up raids he believed might have destroyed ball-bearing production entirely. The cost would have been high; AAF leaders were not able to pay the price, and the RAF was unwilling to try. The second raid left 133 planes so badly damaged that it took four months to bring the Eighth Air Force back to anything approaching full strength. Deep-penetration raids were suspended until long-range fighters became available in 1944.

In retrospect, the raids proved that with better fighter escort AAF bombers could play a decisive role in the war. The raids also had a greater effect on the enemy than anyone at the time realized, especially in regard to jet production. They forced Germany's already depleted industrial resources to focus on defensive fighter production and not offensive aircraft that could have made a difference elsewhere.

William Head

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SENTRY (Samos) Reconnaissance System

One of two technological approaches to satellite photography pursued by the first U.S. photoreconnaissance satellite program, Project WS-117L. CORONA satellites returned their film to earth via capsule for development. SENTRY (Samos) satellites developed the film onboard, scanned the film, converted the data into electrical signals, and transmitted the data to earth, where the data were reconverted into photographs. Ultimately, CORONA proved more successful, and only two Samos satellites reached orbit before the program was cancelled in 1962.

Project WS-117L commenced in March 1955 when the U.S. Air Force requested studies of a satellite system. In late 1957, after the Soviet Union launched Sputnik 1, President Eisenhower approved a major increase in funding for satellite programs. Both SENTRY and CORONA proceeded in parallel to ensure that at least one program would succeed. Samos 1 was launched on 11 October 1960, but failed to reach orbit. Samos 2 went aloft on 31 January 1962 and transmitted photographs for nearly a month. Samos 3 and Samos 4 (9 September and 22 November 1961) failed to achieve orbit. The final launch (22 December 1961) orbited until 14 August 1962.

Samos satellites were 22 feet long, weighed about 4,100 pounds without fuel, and were launched on Atlas Agena boosters from Vandenberg AFB. Samos ground resolution was about 20 feet, and an electronic intelligence package intercepted Soviet radar signals. Most sources contend that Samos produced no useful imagery. One source, however, claims that imagery from Samos 2 contributed to the demise of the so-called missile gap in late 1961.

James D. Perry

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Seversky, Alexander P. de (1894–1974)

Russian national and veteran of World War I; emigrated to the United States and began a aircraft-manufacturing firm. Seversky flew with the Imperial Naval Air Service and lost a leg when he was shot down in 1915. Unfazed, he convinced his commanders to allow him to fly with his artificial leg. Ultimately, Seversky was credited with shooting down 13 German aircraft before the Russian government reached an armistice with Kaiser Wilhelm in 1917.

In early 1918, Seversky received a commission to study aircraft design and manufacturing in the United States. While Seversky was in the United States, the Bolshevik revolution in his homeland made it exceptionally dangerous to return. Seversky heard of the mass executions of his fellow officers and promptly applied for U.S. citizenship.

During his early years in America, Seversky gained a position as a test pilot and consultant with the fledgling U.S. Army Air Service. Seversky's brilliance was quickly recognized, and he was assigned as an assistant to General William "Billy" Mitchell. During the next 8 years, Seversky applied for no less than 360 U.S. patents, including a gyrostabilized bombsight purchased by the Army Air Corps. In addition, Seversky managed to obtain a commission in the Army Air Corps Reserve.

Major Seversky formed a company registered as Seversky Aero Corporation. Unfortunately, the small firm did not survive the stock market crash of 1929. Undaunted, Seversky attracted enough investors to form a new firm. In February 1931, elected president of the new Seversky Aircraft Corporation, Seversky quickly surrounded himself with several expatriate Russian engineers, including Michael Gregor and the man who would ultimately head the P-47 design team, Alexander Kartveli. The Russian connection quickly produced results. Edo Aircraft Corporation of College Point, Long Island, New York, manufactured the first design under contract. Designed as a low-wing monoplane, the SEV-3 was a floatplane. Edo, being the leading manufacturer of aircraft floats, was an ideal choice considering that Seversky had no manufacturing facilities. Even with Edo's expertise, however, construction took two years, largely due to lack of capital funds. Finally, in June 1933 the SEV-3 took off from Long Island waters with Seversky at the controls. Painted in a stunning bronze, the SEV-3 was one of the more advanced aircraft in the world. Several months later and fitted with a more powerful engine, the SEV-3 set a new world speed record for amphibians. One major contributor to the excellent speed of the plane was its broad, semielliptical wing. This distinctive wing was used for the P-47 a decade later.

Economic and political difficulties forced the Seversky Aircraft Corporation out of business, its assets taken over by Republic Aviation. Seversky continued to write and was an advocate of airpower, his principal work being *Victory Through Airpower.*

Albert Atkins

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Seversky Aircraft

U.S. aircraft manufacturer founded by Alexander de Seversky, a Russian immigrant and aviation pioneer. The firm was founded by Seversky in February 1931. Design work on its first aircraft, the all-metal three-place SEV-3 executive aircraft, began that year, and it flew in June 1933 (license X-2106), powered by a Wright R-975 350-shp engine that was soon upgraded to 420 shp. Its initial configuration was as a twin-float amphibian with the floats hydraulically adjustable to optimize their angle of incidence for landing on water or land; retractable wheels were buried in the floats.

In October, the SEV-3 set a world speed record for amphibians (180 mph), and the Columbian air force ordered three in 1934. The wing was a semielliptical planform with a very thin airfoil and was used with very little change on all Seversky aircraft through the P-47 Thunderbolt. As the SEV-3L, the plane was revised to a fixed, spatted, wheeled landing-gear configuration and entered in the 1934 Army trainer competition. During this competition, the SEV was reworked as the SEV-3XAR and won the competition for 30 trainers, being designated the BT-8 and powered by a Pratt and Whitney R-985. The first production BT-8 was delivered in February 1936, and the last was delivered before the end of that year. In the summer of 1935, the SEV-3 was converted back to float configuration, reengined with an R-1820 of 750 shp, and entered the Thompson Trophy race, taking fifth place. Shortly thereafter it set another speed record at 230 mph.

The second Seversky prototype, the SEV-3M, also an SEV-3 design (license X-18Y), was built as a two-place landplane with fixed spatted landing gear, almost identical to the first prototype, and initially powered by a Wright XR-1670 twin-row engine of 775 shp. Variations of the design won the 1935 Army pursuit competition, Seversky receiving an order in June 1936 for 77 SEV-1XPs as the P-35, with Pratt and Whitney R-1830 850-shp engines. The first production P-35 flew in April 1937. The penultimate P-35 was delivered in August 1937. The last P-35 was retained and modified with lengthened fuselage, a 1,200-shp R-1830, and flush-retracting gear as the XP-41.

Sixty fighters ordered by Sweden as EP-1-106s were requisitioned by the U.S. government and designated P-35A. They featured a lengthened fuselage and the 1,050-shp R-1830 but were identified as Republic aircraft. The third Seversky prototype, the SEV-X-BT (license N-189M), started design early in 1936 as an improved BT-8, with an R-1340 engine of 550 shp and retracting landing gear. Reequipped with an R-1820 engine of 875 shp, it was designated 2PA Convoy Fighter and flew in July 1937. Twenty were sold to Russia as 2PA-Ls with 1,000-shp Cyclones, being delivered in late 1937 and early 1938, and 20 were sold to Japan as 2PA-B3s with 1,000-shp R-1830s.

In 1938, Seversky built the AP-7 (NX-1384), which flew in May, with a 20-inch fuselage extension to test as a remedy for ground-looping problems with the P-35. The AP-7 set a transcontinental speed record in August 1938 and won the Bendix Trophy race in September. In 1941 it was sold to Ecuador.

Sweden bought 120 EP1s as single-seat fighters and 52 2PAs as two-seat dive bombers. The U.S. government sequestered 50 of the 2PA dive-bombers, redesignating them as AT-12 Guardsmen advanced trainers.

The AP-4 (NX-2597) was designed with a turbocharger mounted in the baggage space behind the cockpit of the P-35/AP-1. It was built in parallel with the XP-41, had flush-riveted skin, and flew in January 1939. Thirteen of the turbocharged AP-4 with the R-1830 were ordered as the YP-43 and 154 as Republic P-43s.

After building other prototypes, in September 1939 Seversky was ousted from the corporation bearing his name. The firm was renamed Republic Aviation Corporation.

Douglas G. Culy

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Shenyang J-6 and J-8

Supersonic jet fighters built by the Shenyang Aircraft Corporation in Manchuria, formerly a Japanese aircraft assembly facility. These advanced airplanes began serving the newly formed People's Republic of China (PRC) in 1949. Initially, Soviet-built MiG-15 and MiG-15 *bis* jet fighters were assembled at the facility after being shipped by rail from the Soviet Union. The Shenyang facility became the focal point for the construction of a modern Chinese air force in 1953 and today still produces fighter aircraft as well as civilian aircraft and other products. Although the MiG-15 provided the People's Liberation Army Air Force (PLAAF) with an effective interceptor for the still poorly trained Chinese pilots to use against the USAF and Taiwanese pilots during the early 1950s, it was not built by the Chinese themselves.

Mao Tse-tung and the Chinese communist leadership wanted to demonstrate that the PRC was ready to take its place among the Great Powers. In order to do so, the Chinese needed to produce modern weapons. The Sino-Soviet alliance lasted long enough for the Chinese to receive enough aid to begin building their own aircraft.

The first supersonic jet aircraft built in the PRC was the Jianjiji-6 (J-6; Fighter Aircraft-6). The J-6 was a license-built version of the Soviet MiG-19 and began service with the PLAAF in 1958. Although the MiG-19 was phased out of production in the Soviet Union by the 1960s, the J-6 served into the 1990s in the PRC. Although the J-6 was a qualitative step forward for Chinese military aviation, it was still a foreign design, and its length of service revealed the inherent weakness of Chinese technology.

The Jianjiji-8 was the first jet fighter designed by the Chinese. Although derived in part from the Soviet MiG-21 (J-7 in Chinese service), the J-8 was developed by the Chinese beginning in 1964. In the case of the twin-engine Mach 2 J-8, it was not Chinese technology that delayed production but rather Chinese politics. The massive dislocations of Mao's Great Leap Forward and Cultural Revolution kept the F-8 on the drawing board until 1979. By then the aircraft was several generations behind U.S. and Soviet frontline fighters.

The April 2001 collision between a PLAAF F-8IIM and a U.S. Navy EC-121 spyplane revealed that the F-8 was still serving, albeit in upgraded versions, as a modern interceptor. The PRC has returned to its Russian partner to begin upgrading its air forces with Su-27 and Su-30 aircraft. China has yet to solve the problem of domestically producing high-tech weapons systems and aircraft. The development of the Shenyang J-6 and J-8 are excellent illustrations of China's struggle to be a world-class power.

Mark A. O'Neill

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Short Aircraft (Early Years and World War I)

The Short Brothers firm was one of the pioneers in British aviation, starting in the days when all aircraft more or less resembled the box-kite format first employed successfully by Wilbur and Orville Wright in 1903. In 1911, they began a relationship with the British Admiralty as the result of the loan of a Short aircraft by Francis McClean, who intended to help naval officers learn to fly.

In the years that followed, Short played on that relationship by specializing in seaplanes and the development of all things having to do with naval aviation. These latter devices included such peripheral items as floats, wheel float attachments, airbags used as floats to keep wings out of the water, folding wings that enabled aircraft to be stored more efficiently aboard ship, wing attachments for lifting aircraft out of the water with shipboard cranes, experimental armament arrangements for naval aircraft, and the airborne launching of torpedoes.

The Short 184 was the large seaplane workhorse of World

War I. Spanning more than 63 feet, it had a 40-foot fuselage and stood more than 13 feet tall. Power could be provided by a variety of 225–275-hp Sunbeam engines, a 240-hp Renault, or the 250-hp Rolls-Royce Eagle. Armament consisted of a single Lewis machine gun and any combination of bombs totaling 500 pounds, these being carried on a straight-line external rack slung under the fuselage.

More than 650 Short 184s were built, and nearly 300 of those were still in service with the Royal Air Force at the time of the Armistice. The Short 184 was used at RNAS stations throughout the British Isles as well as in France, Italy, and throughout the Mediterranean. One Short 184 was flown by the immortal "Rutland of Jutland"—Lieutenant F. J. Rutland, who spotted German ships at Jutland on 31 May 1916. It also saw service on the *Ben-my-Chree, Raven II, Anne, Campania, Empress, Engadine, Furious, Nairana, Pegasus, Riveria, Vindex, City of Oxford, Auethusa,* and *Aurora.* One Short 184 went to Japan.

Of the more than 20 Short types produced, most were intended for use on the water. One exception was the Short Bomber, a landplane conversion of the famous Short 184 seaplane. The bomber was fitted with wings of unequal span, the upper wing being considerably longer than the lower, its overhang being braced by wires running from the bottom of the interplane struts on the lower wing out near the tips and then up to tall kingposts. Ailerons were fitted to the upper wing only. Of course, the undercarriage was also different, consisting of four wheels connected to the fuselage by a maze of struts and the customary tailskid. Power was provided either by a 225-hp Sunbeam or the 250-hp Rolls-Royce Eagle. Defensive armament was on the light side, only a single Lewis gun being carried, but for offensive purposes the Short could carry four 230-pound bombs or eight 112-pounders. Only limited use was made of the Short, the decision having been made to concentrate on other types, notably the Handley Page.

James Streckfuss

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Short Aircraft (Post–World War I)

Great Britain's Short Brothers firm added to its successful World War I aircraft with the introduction of the all-metal Silver Streak biplane in 1920, which foreshadowed the use of aluminum alloy in their later projects.

Short was best known for its large multiengine flying boats, which included such biplane types as the Singapore, Calcutta, Sarafand, and Kent. Both France and Japan built Short aircraft under license. The biplane formula carried over to a series of stately landplanes used for air transport by Imperial Airways. The company led the world with the introduction of a line of cantilever monoplane flying boats that included the Empire series and led to the classic Sunderland of World War II. Another Short contribution to World War II was the four-engine Stirling heavy bomber.

In the postwar period, Shorts (as it became known) produced a whole series of prototypes, some of very advanced design ranging from high-speed research aircraft to VTOLs to jet transports. It had small production runs of the Seamew antisubmarine aircraft and the very large four-turboprop-engine Belfast. However, the firm survived primarily by subcontracting parts or producing the designs of other companies. It reentered moderately large scale production with the introduction of the Skyvan series of light utility transports. These were transformed over time from the very boxy look of the first aircraft to quite sleek 32-passenger airliners. The Skyvans have been sold worldwide. Shorts was purchased by Bombardier in 1989.

Walter J. Boyne

See also

Short Stirling; Short Sunderland

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Short Stirling

Unique in RAF history as the first four-engine monoplane bomber designed from the outset as such. The specification issued in 1936 also placed a restriction on the wingspan to match the available 100-foot hangar width. This resulted in the aircraft receiving a very-low-aspect ratio wing.

This design limitation meant the Stirling suffered from a lack of service ceiling; the wing spar and fuselage design meant that the bomb bay was restricted in the size of bombs that could be carried. The first prototype first flew on 14 May 1939, although it was destroyed upon landing. Service deliveries began to No. 7 Squadron in August 1940, operations beginning soon afterward. The first operation of note was against the German capital ships *Scharnhorst* and the *Gneisenau* in Brest Harbor.

Further notable actions took place during the 1,000-bomber raids, interspersed with daylight raids across occupied Europe. On one raid against Turin, the first Victoria Cross for the RAF was awarded to Flight Sergeant R. H. Middleton.

When more Lancaster and Halifax bombers became available, the Stirling was relegated to less arduous roles, such as minelaying, and special duties involving radio and radar countermeasures. As the war progressed, duties changed to target-towing, for which purpose the nose was modified and towing equipment fitted in the rear fuselage. The last version of the Stirling was built purely from the outset as a transport and lasted in RAF service until replaced by the Avro York beginning in 1946.

Kev Darling

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Short Sunderland

British flying boat based on a 1933 Air Ministry order. Short Brothers began development of what would become the S.25 Sunderland naval four-engine flying boat. The first prototype flew on 14 October 1937, though the wing and power plants were already being improved. The first squadron equipped was in Singapore in 1938, by which time British home squadrons were also being equipped as aircraft came off the production line. Steady improvements through Mks.I–V improved the aircraft's performance in the air, though at some disadvantage in water handling.

With a speed of 165 mph and a payload of just under 10,000 pounds, the aircraft had a range of about 1,000 miles. The aircraft was primarily used in long (10–12-hour) patrol and reconnaissance missions, including convoy protection and U-boat searches, as well as some search and rescue. Sunderland production stopped with 749 built (456 were Mk.III) by the end of World War II, though the type would remain in service in Britain to 1957 and elsewhere through 1967. An improved model, the S.45 Seaford, was designed, but only a handful were built. Three dozen copies of both models were converted for postwar civil use.

Christopher H. Sterling

See also

Flying Boats

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Short, Michael C. (1944–)

USAF lieutenant general. Michael C. Short was born in Princeton, New Jersey, on 24 February 1944. He earned a bachelor of science degree from the USAF Academy in 1965 and a master's degree from the University of Southern California in 1974. He was a distinguished graduate at the Air Command and Staff College in 1977 and attended the Industrial College of the Armed Forces in 1985.

General Short has commanded several of the fourth-generation squadrons (334th Tactical Fighter Squadron, 4450th Tactical Group, 335th Tactical Training Wing, 67th Tactical Reconnaissance Wing, and the 4404th Composite Wing). He is a command pilot with more than 4,600 flying hours in fighter aircraft, including 276 combat missions in Southeast Asia. He has flown the F-102, F-106, F-4C/D/E, RF-4C, A-10, A-7, F-l17, F-l5E, and F-16C.

In July 1995, General Short became Chief of Staff for the Allied Air Forces Southern Europe (Naples) and then director of operations at USAF Headquarters Europe (Ramstein). In June 1999, he was commander for Allied Air Forces Southern Europe, Stabilization Forces Air Component and Kosovo Forces Air Component (NATO), and Sixteenth Air Force, U.S. Air Forces Europe (Naples).

He was the air commander during Operation ALLIED FORCE and has since lectured and spoken extensively about the chosen airpower strategy. In brief, General Short argues that the execution of the air operations was compromised for political reasons and that the preferred strategy would have been to engage in an intense strategic air campaign directly against the sources of Slobodan Milosevic's power base. General Short retired from the USAF on 1 July 2000 with many decorations, including the Defense Distinguished Service Medal, Distinguished Service Medal, Distinguished Flying Cross, Meritorious Service Medal, and the Air Medal. He is currently an independent consultant, specializing in training for joint and coalition operations and advising on defense and national security matters in general.

John Andreas Olsen

See also

ALLIED FORCE

SIAI Marchetti

Italian aircraft manufacturer formed on 12 August 1915 as Società Idrovolanti Alta Italia (SIAI) to build flying boats at Sesto Calende. Its founders were Luigi Capè, owner of an industrial sawmill, and Domenico Lorenzo Santoni, who held the Franco-British Aviation license and a patent to brand his aircraft "Savoia" in honor of the Italian royal family. During World War I SIAI also operated a flying school and gradually introduced new seaplanes designed by Raffaele Conflenti, including the S.12, which won the 1920 Schneider Trophy, and the S.16 used by Francesco de Pinedo for his 1925 flight to Australia. This spawned the S.59 (1925), S.62 (1926), and S.78 (1932) that equipped Italian naval aviation.

When Santoni and Conflenti left for France in 1920, Capè recruited Alessandro Marchetti (1884–1966), who also acquired a shareholding and in 1937 added his name to the company—which, confusingly, still referred to aircraft as "Savoia." Starting from the S.51 racer (1922), Marchetti launched a series of new designs, the most famous of which was the twin-hulled S.55 flying boat (1924) used to cross the Atlantic in formation in 1930–1931 and 1933. Almost overnight, SIAI became the leading Italian airframe manufacturer. The twin-boom layout was successfully replicated on the S.66 trimotor passenger seaplane (1931) and S.64 long-distance record landplane (1928) but failed on the S.65 Schneider Trophy racer. Finally, by mating the wooden outer wings of the S.55 to a steel-tube fuselage and fixed landing gear, Marchetti created the S.73 trimotor airliner (1934). Its S.81 bomber derivative saw extensive use in Ethiopia and Spain; transport variants were still in production in 1943.

In 1934, the S.79 introduced a completely new wing and advanced features including retracting landing gear, variable-pitch propellers, flaps, and slats. Conceived as a racer, the sleek trimotor was adopted as a medium bomber but found permanent fame beginning in 1940 as a torpedo-bomber across the Mediterranean. Production ceased in 1943 after more than 1,200 had been built by SIAI and licensees; derivatives included the S.83 airliner and twin-fin S.84. Although larger, the S.75 airliner (1937) and S.82 military transport (1940) were essentially similar, including the wooden wing and steel-tube fuselage. Now firmly established as an airplane manufacturer, SIAI in 1938 built a new factory and airfield at Vergiate. Several prototypes were flown in the following years, but all attempts to diversify production failed. Worse, SIAI failed to master the complexities of all-metal construction, creating a technological gap that proved impossible to bridge.

Unsurprisingly, postwar SIAI survived on overhauls and subcontracts, adding small batches of the SM.95 airliner (1945), SM.102 general-purpose twin (1949), and FN.333 amphibian (1952). Marchetti retired in 1960, and SIAI was acquired by the Protto family, whose business plan focused on a family of light aircraft that included the S.205 (1965) and S.208 (1967) four-seaters, S.210 six-seat twin (1970), and S.202 basic trainer (1969). Although about 800 were built over 15 years, these in-house designs were eclipsed by the success of the SF.260 sportplane and trainer (1964) conceived by Stelio Frati (1919–), still in production in 2001 with more than 900 exported to 26 countries.

SIAI also built the SM.1019 observation plane (1969), in essence a turbine-powered Cessna L-19, but was acquired by Agusta in 1973, and helicopter subcontracts soon represented 65 percent of its workload. Unsuccessful attempts to renew the product line centered around the SF.600 utility twin-turboprop (1978) and the S.211 jet trainer (1981), entered in the U.S. J-PATS competition under the Grumman banner. The SIAI story ended in late 1996, when Agusta sold its fixed-wing business to Aermacchi, which transferred production and support to Venegono. Agusta retained Vergiate, but the historic Sesto Calende factory was torn down.

Gregory Alegi

See also

Aermacchi; Agusta; Balbo, Italo; Italian Aircraft Development; Regia Aeronautica (Pre–World War II); Regia Aeronautica (World War II)

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Signals Intelligence (SIGINT)

Intelligence that derives from the interception and decryption of enemy signals traffic. SIGINT can be further broken down into several categories of intelligence, specifically communications, electronics, radar, laser, and nonimaging infrared intelligence. SIGINT has traditionally been considered one of the most important and sensitive forms of intelligence. Indeed, it has been suggested that the British decryption of German radio signals during World War II shortened the war by two years. The ease with which signals can be intercepted and understood by the enemy depends on the method of transmission, the frequencies employed, and the encryption system used to conceal the content of the signal from unauthorized personnel.

SIGINT can provide data on a nation's diplomatic, scientific, and economic plans or events, as well as the characteristics, capabilities, and often intentions of its armed forces. For example, during the North African campaigns during World War II, the British had virtually unlimited access to Italian codes and ciphers with beneficial results in what has been described as a perfect (if rather miniature) example of the cryptographers' war.

Brad Gladman

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Sikorsky, Igor I. (1889–1972)

Pioneer aviator and innovative designer of fixed-wing and rotary-wing aircraft. The son of a pre-Freudian psychiatrist in Kiev in imperial Russia, Igor I. Sikorsky studied math and engineering at the Russian Naval Academy in St. Petersburg and the Polytechnic Institute of Kiev. Science fiction by Jules Verne and European flight demonstrations by Wilbur Wright sparked his interest in an aviation career.

Sikorsky traveled to Paris in 1909 and learned aeronautical principles from French pioneers such as Louis Blériot. Returning to Kiev, he made two unsuccessful attempts to build helicopters before designing the first of his Winged-S airplanes. The S-6, a tractor biplane, won prizes as well as the Russian military competition of 1912. His triumph led to financial rewards and a contract with the Russo-Baltic Wagon Company, which subsidized his design (1912–1913) of a four-engine behemoth, the Grand. Its successor, the "Ilya Muromets," broke world records and flew in the summer of 1914 on a 1,500-mile round-trip between St. Petersburg and Kiev. The outbreak of World War I overshadowed the spectacular cross-country flight. Nevertheless, Russia's military appreciated Sikorsky's accomplishment and ordered the "Ilya Muromets" into production as the world's first four-engine bomber-reconnaissance aircraft.

The 1917 Russian Revolution interrupted Sikorsky's career as well as Russia's participation in the war. Bolshevik ascension to power during the revolution's second phase prompted Sikorsky to flee Soviet Russia and travel first to France (1918) and then to the United States (1919).

Employed briefly by the U.S. Army Air Service at McCook Field (later Wright-Patterson) in Dayton, Ohio, Sikorsky designed a U.S. bomber that went unfunded. He then journeyed to New York City, where he taught math at an institute and contacted members of the Russian émigré community. These contacts enabled him to finance in 1923 the Sikorsky Aero Engineering Corporation.

The company's most successful multiengine product, the S-38 amphibian, gained national attention for Sikorsky and 111 sales contracts to various buyers such as Pan American Airways. Moving from Long Island, New York, to a new facility in Stratford, Connecticut, Sikorsky in 1929 merged his firm with United Aircraft and Transport Corporation (later United Technologies). Although the originator of luxurious flying boats, Sikorsky faced a small market filled in the 1930s with stiff competition from Boeing and Martin. Moreover, he lost out to Consolidated in his bid to secure a U.S. Navy contract. As a result, United Aircraft turned over a major portion of the Sikorsky plant to another subsidiary, Chance-Vought Aircraft.

Meanwhile, Sikorsky returned to his first love—helicopters. In the early 1930s, he applied for a U.S. patent for a single-rotor helicopter, then built and tested in 1939 the VS-300. The military version, the R-4 and variants R-5 and R-6, entered serial production during World War II. By war's end, a total of 425 Sikorsky helicopters flew for the U.S. Navy, Coast Guard, and Army Air Forces. Conceived initially as a tactical reconnaissance vehicle, it also proved its worth in air rescue and transport missions, roles reconfirmed during the Korean War.

Sikorsky retired from the Sikorsky Division of United Technologies in 1957. He then devoted time to revising his memoirs and preparing mystical tracts entitled *Message of the Lord's Prayer* and *The Invisible Encounter.* He received numerous awards, including the prestigious Collier Trophy for his life's work in aviation in 1951.

James K. Libbey

See also

Air Rescue; Boeing Company; Consolidated Aircraft Corporation; Martin Aircraft; Sikorsky, Igor I.; U.S. Army Air Forces; U.S. Army Air Service; U.S. Coast Guard Aviation; United Aircraft Corporation; United States Navy, and Aviation; Wright, Wilbur

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Sikorsky S-55/H-19 Chickasaw

Utility, troop transport, antisubmarine warfare, and search-and-rescue helicopter used by all U.S. military services and many other nations. Military use of the S-55 began in 1950. The U.S. Army and Air Force designated it the H-19, the Army calling it the "Chickasaw." The Marines designated it the HRS and the Navy the HO4S. Sikorsky and foreign licensees produced more than 1,800 S-55s in many different models.

The S-55 was bulky in appearance, with a cabin seating 10–12, a three-blade rotor, a high tailboom, and a tailrotor. The radial engine was mounted in the nose at a 45-degree angle to the rotor mast, and the two pilots sat atop the cabin and engine. The Soviet Mi-4 Hound closely resembled the S-55.

The S-55 saw service during the 1950s in the Korean War, British counterinsurgency operations in Malaya, the Algerian War, and the British-French attack on Suez.

John L. Bell

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Sikorsky S-61R/CH-3/HH-3 Jolly Green Giant

Transport helicopter. In June 1967, two Sikorsky HH-3Es completed the first nonstop helicopter crossing of the Atlantic Ocean. Supported by nine aerial refuelings, they flew from New York to the Paris Air Show in 30 hours, 46 minutes. At the time, the HH-3E, equipped with two General Electric T58-GE-5 1,500-shp turboshaft engines and designed for the combat rescue mission, was the latest variant of the Sikorsky S-61 series. Earlier versions had been developed for the U.S. Navy in rescue and antisubmarine roles.

The U.S. Air Force first used S-61 series helicopters in 1962 when borrowed Navy aircraft supported the offshore radar-operating Texas Towers. The S-61R, with its rear loading ramp and retractable undercarriage, first flew in 1963 and was used by the USAF as the CH-3E and HH-3E and by the Coast Guard as the HH-3F. Redesignated from SH-3As to CH-3A/Bs, good long-range performance resulted in an Air Force order of 75 CH-3Cs equipped with a new rear fuselage design with cargo ramps that enabled straight-in loading and T58-GE-1 engines.

In 1966, the CH-3E was introduced for combat and special operations and equipped with the uprated 1,500-shp GE-5 engines and pod-mounted turrets, with NATO 7.62mm miniguns, on each sponson. HH-3Es, with GE-5 engines, armor, self-sealing fuel tanks, rescue hoist, and a retractable aerial-refueling probe were designated for combat rescue. They became known as "Jolly Green Giants" during their Vietnam service.

The U.S. Coast Guard version of the S-61R, designated the HH-3F, began manufacture in 1968. Advanced electronics were added for the search-and-rescue mission. Combat-related features were removed.

Charles Cooper and Ann Cooper

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Sikorsky S-64 Skycrane/CH-54 Tarhe

U.S. heavy-lift helicopter. The enormous and versatile Skycrane transported construction equipment and armored vehicles, carried downed aircraft to safety, and even dropped bombs on a few occasions. Some of the records Skycranes set decades ago stand today.

The first six aircraft, Model YCH-54A, were built in 1962 and 1963. After testing and evaluation at Fort Benning, Georgia, 54 CH-54As were built, first entering Army service in late 1964. The Skycrane (almost never referred to as "Tarhe") was equipped with a six-blade main rotor powered by two Pratt and Whitney T73 engines for a total of 9,000 shaft horsepower. Seventy feet, 7 inches long, with a rotor diameter of 72 feet, the CH-54 weighed 19,234 pounds empty, could take off at a gross weight of 42,000 pounds, and achieve a top speed of 126 mph. It was flown by a crew of three, with the third pilot facing aft and operating the 15,000-pound-capacity hoist. Thirty-seven additional CH-54Bs, with uprated engines and twin-wheeled landing gear, were built in the late 1960s.

When not using the hoist, the Skycrane carried interchangeable universal military pods, also built by Sikorsky. Pods could be fitted out as troop transports, field hospitals, mobile command posts, or communications centers.

The CH-54 served in Vietnam with the 478th Aviation Company, also known as the 478th Heavy Helicopter Company, supporting the 1st Cavalry. In addition to hauling bulldozers and graders, Skycranes had retrieved more than 380 damaged aircraft by the end of 1969. The 478th also dropped 10,000-pound bombs from a Skycrane in 1968, near the demilitarized zone. The bomb was released from 6,000 feet and fused to explode 4 feet above the ground, creating an instant landing zone. Only one crew was lost to enemy fire in Vietnam. Several other Skycranes were shot down, but the crews survived.

After Vietnam, CH-54s in military service were transferred to the Army National Guard. Retired from National Guard service in the early 1990s, most Skycranes are now in civilian use, still providing heavy-lift service. Many have been modified for firefighting use as waterbombers (redesignated S-54E).

Among the many world records set by the CH-54B are maximum altitude in horizontal flight (36,122 feet), maximum altitude with a 15,000-kilogram payload (10,850 feet), time to climb to 3,000 meters (1 minute, 29.9 seconds), and time to climb to 9,000 meters (5 minutes, 57.7 seconds).

Mark E. Wise

See also

Helicopter Operations, U.S. Army; Helicopters, Military Use; Sikorsky, Igor I.; U.S. Army Aviation (Operations)

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Sikorsky S-65/CH-53 Sea Stallion

A two- or three-engine helicopter with wide field applications. The first S-65 flew on 14 October 1964 and went in production as the CH-53A "Sea Stallion" for the USMC. The Sea Stallion was involved in the Vietnam War, Grenada, Panama, Lebanon, and the Gulf War.

The S-65 was also designated MH-53A and used as a minesweeper. The CH-53D was the more powerful version of CH-53A. The MH-53J Pave Low was used by Special Forces. The HH-53B became the "Super Jolly" as a transport for USAF. It had more powerful engines and additional fuel tanks. The HH-53C was an improved HH-53B with better engines and seating for 44 troops; the RH-53A was a minesweeper; and the S-65C was a passenger helicopter. The YCH-53E a three-engine prototype, first flown on 8 December 1975.

Henry M. Holden

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Sikorsky S-70

Twin-engine helicopter designed to replace the Huey UH-1. The Sikorsky prototype competed against the Boeing-Vertol YUH-61A and won. The S-70 first flew on 17 October 1974 and went into production in 1978. A number of modifications to the S-70 were undertaken, including the UH-60A Black Hawk—utility helicopter for the U.S. Army; EH-60A—electronic countermeasures; HH-60A Jayhawk—rescue helicopter; SH-60B Seahawk—also known as S-70L, naval antisubmarine and patrol helicopter; SH-60C—fitted with CV-HELO sonar; MH-60 Pave Hawk—special forces helicopter; and S-76—passenger version. All U.S. military branches and the U.S. Customs service currently use it.

Henry M. Holden

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Sikorsky UH-60 Black Hawk

Light transport helicopter first flown in October 1974; used for air assault, air cavalry, and aeromedical evacuation units. The UH-60A was developed as result of the Utility Tactical Transport Aircraft System program. The Black Hawk is the primary division-level transport helicopter, providing dramatic improvements in troop capacity and cargo-lift capability compared to the Huey UH-1 series it replaces. The UH-60A, with a crew of three, can lift an entire 11-man fully equipped infantry squad in most weather conditions. It can be configured to carry four litters, by removing eight troop seats, in the medevac role. Both the pilot and copilot are provided with armor-protected seats; protective armor can withstand hits from 23mm shells. The Black Hawk has a cargo hook for external lift missions, provides for a door mounting for two M60D 7.62mm machine guns on the M144 armament subsystem, and can disperse chaff and infrared jamming flares using the M130 general-purpose dispenser. It has a composite titanium and fiberglass four-blade main rotor, is powered by two General Electric T700-GE-700 1,622-shp turboshaft engines, and has a maximum cruising speed of 184 mph.

The UH-60 is the Army's first true squad assault helicopter to transport troops and equipment into combat, resupply medevac troops while in combat, reposition reserves, and perform command-and-control functions. It can transport a lightweight 105mm howitzer with crew and ammunition, with the range, endurance, and maneuverability required of a highly effective tactical assault vehicle.

The Army has two series in the fielded fleet. Delivery of the UH-60A began in 1978 and continued through September 1989, with a total of 980 delivered. In October 1989, with an improved durability main gearbox and an updated engine, the UH-60L series was introduced. Survivability characteristics include low-reflective paint; invisible engine smoke and flame; crashworthy armored crew seats; redundant flight controls, hydraulic systems, and electrical systems; crashworthy self-sealing fuel system; engine and auxiliary power unit fire-detector and -extinguisher system; wire cutters; and the Hover Infrared Suppression System to reduce the infrared signature of the engine exhaust.

Dennis R. Jenkins

Developed in 1974 as result of the Utility Tactical Transport Aircraft System (UTTAS) program, the Sikorsky H-60 offers dramatic improvements in troop capacity and cargo lift capability over earlier helicopters. (Walter J. Boyne)

See also
Combat Search and Rescue

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Single Integrated Operation Plan (SIOP)

Framework for U.S. war planning; articulates U.S. nuclear doctrine. Strategic warfare in the Cold War quickly became defined in terms of nuclear weapons and the destruction of an opponent's leadership, industry, military, and infrastructure. Planning for such a contingency began piecemeal, with each military service developing a separate plan, replete with excessive target redundancies plotted by other services. Moreover, the war plan was an absolute: peace or all-out nuclear conflagration, something economist Herman Kahn called "wargasm."

In August 1960, President Dwight D. Eisenhower authorized the Joint Strategic Target Planning Staff, responsible for producing a National Strategic Target List and the SIOP. The first of these was SIOP-62, which took effect on 15 January 1961 and provided for massive strikes against the Soviet Union and the People's Republic of China. The only option in SIOP-62 was its status as a preemptive attack or a retaliatory attack.

The following year SIOP-63, at the behest of Secretary of Defense Robert S. McNamara, allowed considerable selectivity. Major Attack Options, for example, enabled the president to launch a handful or hundreds of weapons at precise targets. In 1982, China was dropped from the SIOP, but Chinese targets were retained for Strategic Reserve Force strikes. SIOP-6F in 1989 saw a shift in emphasis to leadership and mobile targets, especially Soviet SS-25 ICBMs, as well as the development of adaptive target planning.

With the collapse of the Soviet Union and the end of the Cold War, SIOP refocused on Third World countries pursuing weapons of mass destruction. During 1997, President Bill Clinton issued Presidential Directive PD-60 on guidelines for atomic weapons, which reaffirmed this shift toward targeting so-called rogue states—nations with threatening nuclear, biological, and/or chemical capabilities. As such, by 1999 China was once again included in the SIOP. Aside from providing a sense of order to U.S. warplans, SIOP articulated U.S. nuclear doctrine from global holocaust to mutual assured destruction to a "winnable" nuclear war to strategic warfare with Third World.

Robert S. Hopkins

See also
Atomic Bomb; Cold War; Massive Retaliation; Mutually Assured

Destruction; Strategic Air Command; Strategic Triad Concept; U.S. Air Force Doctrine

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Six Day War

Few events in the history of airpower compare with the decisive aerial operations of the June 1967 Six Day War. Working from the idea of an overwhelming preemptive attack, Israeli Air Force (IAF) planners decided to destroy the bulk of the Arab air forces on the ground, thereby eliminating their vast numerical advantage. The plan—code-named MOKED—was developed by IAF pilot Jacob Nevo and proved a spectacular success. Some 400 Arab aircraft, the bulk of them Egyptian (including 30 Tupolev Tu-16 bombers), were destroyed in their ground revetments, while attempting to take off, or in the few aerial battles that did manage to develop.

With the Arab air forces eliminated, the IAF then devoted its attention to supporting Israeli ground forces, which captured the Sinai Peninsula, the Golan Heights, and the whole of Jerusalem. The Israeli victory solidified the reputation of the IAF as nearly invincible, contributing to a mystique of a flawless and impeccable fighting force. One dark moment for the IAF, however, was the intentional attack on the USS *Liberty,* a U.S. intelligence-gathering vessel off the coast of Egypt.

Robert S. Hopkins

See also

Dassault Mirage III; Israeli Air Force; Israel–Middle East Conflicts; Israel–Middle East Wars; USS *Liberty*

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Slessor, John C. (1897–1979)

Marshal of the Royal Air Force. Although highly regarded as an able operational commander and a premier staff officer, RAF Marshal John C. Slessor may be remembered best as one of the great conceptual thinkers of airpower. Born in 1897, Slessor volunteered for the Royal Flying Corps in 1915 when his childhood polio prevented army service. He flew pursuit aircraft in the Sinai and Sudan, as well as home defense against Zeppelins.

During the interwar years, Slessor commanded No. 4 Squadron (Army Co-Operation) from 1925 to 1928 and No. 3 (Indian) Wing from 1936 to 1937, but he was best known as a talented writer. Noticed by legendary Chief of the Air Staff Hugh Trenchard in the 1920s, Slessor served as the chief's ghostwriter for policy papers, speeches, and articles. He articulated and honed the RAF's interwar air doctrine. Ironically, although a devoted "bomber man," Slessor's 1936 *Air Power and Armies* represented the best book on air-land warfare before World War II. He examined mechanization and airpower's impact on history and emphasized air superiority and interdiction in close cooperation with ground forces.

During World War II, Slessor served as deputy, then as director, of plans, Air Ministry (1937–1941). He commanded No. 5 Group (Bomber Command) during 1941–1942. In January 1943, his draft charted the Combined Bomber Offensive at the Casablanca Conference that largely reconciled Anglo-American doctrinal differences. The same year, Slessor played a role in defeating the U-boat menace as commander in chief (CinC) of Coastal Command.

In 1944, he replaced Air Chief Marshal Arthur Tedder as CinC RAF Mediterranean and Middle East and deputy air CinC Mediterranean Allied Air Forces. As air member for personnel, Air Council, in 1945–1946, Slessor struggled to reduce RAF numbers and create the postwar air force. In 1950, he became Chief of Air Staff and developed the V-bomber force. Upon retirement in 1952, he continued to write and speak effectively; his book *The Central Blue* confirmed his reputation as one of the RAF's great thinkers.

John Farquhar

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Smushkevich, Yakov "General Douglas" (1902–1941)

Soviet air commander during World War II. Yakov Vladimirovich Smushkevich was born on 14 April 1902 in

Lithuania. After fighting in the civil war he transferred to aviation. In September 1936 he was sent to Spain, where he commanded the Soviet air units under the pseudonym "General Douglas." His accomplishments included the air defense of Madrid and the routing by air attack of the Italian Littorio Division at Guadalajara, which became the model for ground attack operations in World War II. He was awarded the Hero of the Soviet Union (HSU) in June 1937. During the summer of 1939, he commanded the Soviet air units engaged over Khalkin Gol, reversing their initially poor performance. He was awarded a second HSU in November 1939 and became chief of the Red Army Air Force. Smushkevich was one of those arrested and blamed for the Soviet catastrophe when the Germans invaded on 22 June 1941 and was shot on 28 October. He was rehabilitated posthumously in December 1954.

George M. Mellinger

See also

Soviet Volunteer Pilots; Spanish Civil War

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SNCASO 4050 Vautour

French attack aircraft conceived in 1951 by Jean Charles Parot. The SNCASO 4050 Vautour (Vulture) was a successful multirole twin-jet transonic aircraft. The first of three prototypes flew on 16 October 1952. In June 1953, it reached over Mach 1 in a dive and on 29 December 1953, 60-year-old Louis Christiaens became the very first "supersonic minister" aboard the same plane.

Two single-seaters and four two-seaters were produced as preseries models. The first of 140 standard Vautour IIs achieved its first flight on 30 April 1956. Only 29 Vautour IIA attack single-seaters were built, plus 40 Vautour IIBs and 70 Vautour IIN night-fighters. A single Vautour IIBR was produced. Carrying a load up to 5,300 pounds, these Armée de l'Air bombers were used from 1958 to 1979. The night-fighters soldiered on from 1957 to 1973. They were equipped with four 30mm cannons and 208 unguided rockets packed internally. Many Vautour IIs flew special missions through atomic clouds and other tests until 1990.

The SO 4050 was selected in 1955 by Israel, which obtained 19 Vautour IIAs, four IIBs, and eight IINs. The night-fighters of Squadron 119 never had a kill and were transferred in 1963 to Squadron 110 for daylight bombing. Vautour attacks were very efficient during the Six Day War (June 1967), destroying many Egyptian, Syrian, and Iraqi planes on the ground. The following war of attrition, in which Egypt and Israel battled for two years, demonstrated again the capacities of the Vautours. They were replaced by much more modern Douglas Skyhawks in 1973.

Stéphane Nicolaou

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Sokolovsky, Vasily Danilovich (1897–1968)

Soviet army marshal and writer on military theory and doctrine. Sokolovsky enlisted in the Red Army in 1918, participated in the Russian civil war, and subsequently graduated from the Voroshilov General Staff Academy and the Frunze Military Academy. He was deputy chief of the General Staff at the start of World War II and was a successful senior field commander in the campaigns against the German army, directing operations that were characterized by close cooperation between the Red Army and Frontal Aviation forces.

Sokolovsky was commander of the Soviet Group of Forces and head of the Soviet Military Administration in East Germany after World War II and was in command at the start of the Berlin blockade in 1948. He was reassigned to Moscow shortly before the blockade was lifted in the face of the successful Berlin Airlift. Marshal Sokolovsky served as Chief of Staff of the Soviet armed forces from 1953 to 1960 and was the senior editor of the influential statement of Soviet military thought, *Military Strategy* (three editions between 1962 and 1968). *Military Strategy* addressed the integration of missiles and nuclear weapons into the Soviet military, with emphasis on how wars would could be fought and won in the nuclear age.

Jerome V. Martin

See also

Berlin Airlift; Frontal Aviation; Soviet Air Force

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Somalia

During the afternoon of 3 October 1993, a U.S. Special Forces team (Task Force Ranger) was sent into downtown Mogadishu, Somalia, to capture two lieutenants of the local warlord Mohamed Farrah Aidid. This operation became known as the Battle of the Black Sea, or *Ma-alinti Rangers* (The Day of the Rangers) to the Somalis. It took place during the UN peacekeeping effort RESTORE HOPE. Two MH-60 Black Hawk helicopters were shot down in the city by Russian rocket-propelled grenades, and two more crash-landed back at the base. Desperate close-quarter fighting took place in confined urban terrain throughout the night at the assault and crash sites and along the avenue of approach of the relief convoys. Aidid's warriors were intermingled with the local populace, the Special Forces team did not have night-vision equipment, and a convoy got lost, which added to the overall confusion of the operation. During the assault and ensuing rescue mission, 18 Delta Force and Army Rangers were killed and dozens more injured. Somali causalities were more than 500 killed and 1,000 wounded. The connection to terrorist Osama bin Laden was discovered later.

Robert J. Bunker

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Somerville, James F. (1882–1949)

Royal Navy vice admiral. Born on 17 July 1882 in Weybridge, Surrey, Somerville entered service aboard HMS *Britannia* in 1897. He served afloat with distinction until April 1938, when tuberculosis invalided him home from command of the East Indies station. He retired as a vice admiral.

When war came in September 1939, Somerville volunteered his services. He distinguished himself in developing radar and then as Vice Admiral Bertram Ramsay's subordinate during the Dunkirk evacuation.

The Royal Navy established a covering force at Gibraltar after France fell with Somerville in command. To neutralize the French fleet, Force H launched successive attacks on Oran and Dakar with aircraft and gunfire. The carrier *Ark Royal*'s aircraft then struck Italian bases at Genoa, Livorno, and on Sardinia and Sicily while Force H covered multiple convoys to Malta from August 1940 to March 1942. Somerville's force also played a decisive role in the *Bismarck* chase in May 1941.

In March 1942, Somerville took command of the Eastern Fleet, conducting holding operations against Vice Admiral Nagumo Chuichi's First Air Fleet Indian Ocean offensive. His carriers covered the Diego Suarez and Madagascar operations in May and September 1942 before withdrawing to serve elsewhere. Somerville's Eastern Fleet carriers recommenced offensive operations in 1944 until he relinquished command in August; he was reinstated an admiral on the active list after five years war service at sea.

Somerville went to Washington, D.C., in October to head the British naval delegation. He became Admiral of the Fleet in May 1945 and retired permanently the next year. Somerville died on 19 May 1949 in Wells, Somerset.

Paul E. Fontenoy

See also

Bismarck, Air Operations Against; Burma; Malaya, Battles of; Malta, Siege of; Mediterranean Theater of Operations

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Somme, Battle of the (1916)

The costliest engagement in British military history; proved significant to the use of airpower and its coordination with the work of the army. The battle opened on 1 July 1916 with the British Army striving to break the deadlock on the Western Front. It lasted until mid-November and cost 600,000 German and 700,000 Allied casualties without any significant results.

During World War I, the fighting brought home the importance of tight relations between the artillery battery and the airplane observer regulating its fire. General Henry Rawlinson, commanding Fourth Army, was prompted to suggest that control of all artillery aircraft actually be moved from the Royal Flying Corps to the artillery, a proposal echoed by H. S. Horne, commander of First Army. RFC Commander Hugh Trenchard was able to argue successfully against these attempts to encroach on his command, pointing out that the work of the RFC squadrons did not merely include artillery-spotting but contact patrol, trench reconnaissance, and trench photography work. The point was made: The days when ground commanders shunned the airplane as a useless toy were over; it was now regarded as an integral part of effective army operations.

It was agreed, though, that observation balloons were a particular concern to the artillery, and arrangements were made for refinements in the structure of balloon organization, including the incorporation of artillery officers as balloon observers. As is discussed elsewhere, by 1918 this approach was being taken by balloon services in other

Touted as the premier allied dogfighter of World War I, the Sopwith Camel replaced the successful Pup in 1917. (Walter J. Boyne)

countries as well, the roster of the U.S. Air Service Balloon Section being split nearly 50-50 between aviation and artillery officers.

Problems with transmission of wireless signals from RFC aircraft to artillery batteries during the battle prompted a close look at the whole system and many changes. Improvements in wireless equipment subsequent to the Somme allowed for a doubling of the number of artillery aircraft. This prompted an increase in the number of aircraft in RFC squadrons from 18 to 24.

Further advances included revision of the way in which zone calls were made and the institution of a special intelligence section within the RFC for better coordination and dissemination of information collected by airplane.

Finally, the level and quality of enemy fighter opposition had increased so significantly during the battle as a result of the German reorganization into *jagdstaffeln* (fighter squadrons) that the lone patrol was no longer possible. It was noted that experienced airmen would thereafter be able to work perhaps in pairs but that in most cases larger formations would be necessary.

James Streckfuss

See also

Royal Flying Corps/Royal Naval Air Service/Royal Air Force

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Sopwith Aircraft

British aircraft manufacturer. In 1912, yachtsman and pioneer pilot Thomas Sopwith established Sopwith Aviation, Ltd., in Kingston-upon-Thames and set out to build aircraft. Although products included both landplanes and seaplanes, its first success was the Bat Boat, a small flying boat.

The company's first major contributions to the war effort came in 1916 with the two-seat 11/2 Strutter and a small single-seater that the government would call the Scout but the rest of the world came to know as the Sopwith Pup.

The 11/2 Strutter, so named because the long arm of its "W" shaped center-section strut appeared to be half the length of its interplane struts, served in a general-utility role. From its introduction to the front, the Strutter flew all sorts of missions, from reconnaissance to bombing to fighter escort. Originally designed as a two-seater, the Strutter was the first British aircraft to sport a synchronized machine gun for the pilot in addition to the Lewis gun for the observer. In No. 3 Wing, Royal Naval Air Service—the first Allied attempt at a strategic bombing unit—the two-seat Sopwith operated alongside a single-seat version intended for use as a bomber. The two-seaters escorted the bombers to and from targets.

Appearing at about the same time as the two-seater, the Pup established a reputation of being delightful to fly. Its 80-hp LeRhone engine and easy-to-handle control surfaces made it a pilot's dream. The Pup played a prominent role in the RNAS, not only with the units operating in Flanders but also in early experiments leading to the development of the aircraft carrier. Even though the German Albatross was a superior aircraft, the Pup was still able to hold its own in a turning contest and hung on until 1917, when it was replaced by the Sopwith Camel.

The Sopwith Tripe triplane was an unusual design when it appeared in RNAS units at the end of 1916, when the biplane was the standard configuration. The layout allowed an increase in lifting area with no additional wingspan and produced an airplane with an impressive rate of climb. This was a tremendous asset in a fighter, and if imitation is the sincerest form of flattery, then the Tripe must have been highly regarded, as it set off a three-wing fad that affected nearly every aircraft manufacturer of the day—British, French, and German. Armed with a single Vickers gun, the triplane could outclimb anything then on the Western Front. This quality, plus its quick maneuverability, made it a deadly mount in the hands of skilled pilots.

The next Sopwith design was the Camel, the work of designers Herbert Smith and Fred Sigrist. Camel flight characteristics have sometimes been compared to riding a polo pony, a quality that contributed to its reputation as one of the war's ultimate dogfighters. The Camel is affectionately regarded—many decades after the fact—as the premier Allied dogfighter of World War I. Highly maneuverable, its tight turning radius made it a challenging opponent for most German fighter pilots. Although praised by those who lived to master its quirky behavior, it was approached with terror by the neophyte.

The Camel's weight was concentrated in its first 7 feet. This mass combined with its rotary engine to create a gyroscopic effect that made right turns potentially lethal. It is said that the Camel killed more in training accidents than it achieved victories, a significant claim considering it is credited with more kills than any other fighter of the war. (The total of these claims varies, according to source, from 1,294 to more than 3,000.)

The final wartime offering from Sopwith was the Snipe, an attempt to improve on the Camel by retaining its good qualities while designing out the control problems that made it difficult. The Snipe featured a more rounded fuselage, wings with dihedral in both upper and lower surfaces, balanced control surfaces, and a more powerful engine, the Bentley BR 2. Intended for use at high altitudes, the Snipe did not see service long enough to build a real reputation for itself. In one exceptional action, however, it distinguished itself highly in the hands of Canadian ace William George Barker.

The Snipe stayed on in the postwar RAF stable. The Sopwith name passed from the scene in 1920, but many workers remained in a new firm named for Sopwith test pilot Harry Hawker.

James Streckfuss

See also

Barker, William George; Sopwith, Thomas O.M.

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Sopwith, Thomas O.M. (1888–1989)

Aviation pioneer and industrialist. Born in London on 18 January 1888, Sopwith received a thorough engineering training. A private income allowed him to pursue his interests in motoring, sailing, and aviation. After learning to fly in 1910, he won several substantial prizes for record flights, enabling him to establish the Sopwith School of Flying and the Sopwith Aviation Company in 1912.

Before and during World War I, Sopwith supplied both British air services with aircraft, particularly a successful series of single-seat scouts whose pinnacle was the Camel. Nevertheless, the postwar contraction hit hard, and he liquidated the company in 1920.

In November 1920, Sopwith's new firm, the H. G. Hawker Engineering Company, began operations. The name was taken from the famous Sopwith test pilot Harry Hawker. Small orders kept it afloat when in 1928 Sydney Camm's spectacularly successful Hart brought substantial contracts, making Hawker the RAF's principal supplier during the next decade. The firm's strength allowed Sopwith to put Camm's next design, the Hurricane, into production three months before receiving a government contract.

Hawker's commanding position enabled Sopwith to create the Hawker-Siddeley Group between 1935 and 1938, combining the Armstrong-Whitworth, Avro, Gloster, and Hawker firms with the Armstrong-Siddeley aero-engine and automobile firm. Postwar, Sopwith took over de Havilland (1959) and Blackburn (1963). That year he retired from his position as chairman, although he remained a member of Hawker-Siddeley's board until 1978, soon after the British government nationalized the firm as British Aerospace.

Sopwith died at his home, Compton Manor, in Hampshire on 27 January 1989.

Paul E. Fontenoy

See also

Armstrong Whitworth Aircraft; Avro Aircraft; Blackburn Aircraft; British Aerospace; Camm, Sydney; De Havilland Aircraft; Gloster Aircraft; Hawker Aircraft; Sopwith Aircraft

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Sosnowska-Karpik, Irena (1922–1990)

Colonel in the Polish air and air defense forces. She was a meritorious pilot-instructor and served as deputy wing commander, Officer Flying School, in Deblin, Poland. Sosnowska-Karpik was a World War II veteran who served with the Polish armed forces formed in the Soviet Union (the Union of Polish Patriots, a predecessor of the communist government in postwar Poland). Sosnowska-Karpik became an outstanding flying instructor after the war.

While serving with the Higher Officer Flying School after the war as pilot-instructor, she trained almost 1,000 new pilots. Upon transferring to the reserves, she had approximately 4,300 flying hours to her credit aboard both fixed-wing aircraft and helicopters.

Sosnowska-Karpik was decorated with the Knight's Cross of the Order of Rebirth of Poland and the Gold and Silver Crosses of Merit, as well as various Polish air force medals and badges.

Kazimiera J. Cottam

See also

Lewandowska, Janina; Polish Auxiliary Women's Air Force Service

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South Atlantic/Trans-Africa Air Route

The principle aerial lifeline for the Allies during the early days of World War II.

As war loomed, the airplane had evolved into an efficient and reliable long-range transport. Germans, British, and Americans were all able to modify existing civilian aircraft designs, resulting in new military versions capable of conducting long-range airlift support for military forces. For the Allies, this capability became absolutely critical as the British homeland came under effective blockade by the Axis powers.

By early 1941, the British were facing daunting demands to support their military forces on battlefields across Europe, the Middle East, North Africa, and Asia. In June 1941, as German U-boats were destroying increasing numbers of surface ships in the North and South Atlantic and as the Mediterranean became more difficult to transit due to Axis air and sea patrols, Prime Minister Winston Churchill turned to the United States for help. Churchill consulted with Juan Trippe of Pan American Airways and U.S. President Franklin Roosevelt about how to move aircraft and supplies to Cairo, Egypt. After negotiations, five separate contracts were signed, and in less that 60 days Pan Am's newly formed subsidiary, Pan American Airways–Africa Limited (PAA-Africa) was organized, personnel were hired and sent to Africa, and the first scheduled flight operations across the South Atlantic and Africa commenced.

The route started in Miami, with planned stops in Port of Spain, Trinidad, and Belem and Natal, Brazil. From Natal, Boeing 314 flying boats and B-24s crossed the South Atlantic, landing at marine terminals in Liberia or airfields in the Gold Coast Colony (modern-day Ghana). In Africa, PAA-Africa built upon a rudimentary route (known as the Takoradi Route) established by the British in the late 1930s. Facilities were established or improved at Fisherman's Lake, Benson Field, and Roberts Field in Liberia; Accra and Takoradi in the Gold Coast; Lagos, Kano, and Maiduguri in Nigeria; Fort Lamy in Chad; El Geneina, El Fasher, and Khartoum in the Sudan; and Luxor and Cairo in Egypt. The Trans-Africa Route eventually extended through the Middle East, then India, and terminated in China. By June 1942, construction was completed at two new airfields, Ascension Island, located in the South Atlantic, and Roberts Field, located in Liberia. Thus, shorter-range aircraft could use the route.

The U.S. Army Air Corps, Pan Am (using several subsidiaries), RAF Ferry Command, Trans World Airlines, and the Free French air forces were all major users of this route. Users facilitated delivery of more than 11,300 Lend-Lease aircraft and vital military supplies to the front lines. Additionally, significant amounts of cargo critical to the war effort was shipped back to the United States over the route (for example, captured military equipment and large quantities of raw materials including platinum, uranium, raw rubber, and mica).

Presidents, kings, generals, and other VIPs used this secure route to travel to and from combat zones and warplanning conferences. For example, Colonel Jimmy Doolittle returned to the United States as a passenger over this route after his historic 1942 air raid on Japan. With Allied victories in North Africa, Europe, and the Pacific, alternate air routes became available, diminishing the Allies' reliance on this vital lifeline.

Thomas M. Culbert

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Southeast Asia Air War (1965–1972)

Air operations conducted over Southeast Asia during the Vietnam War. The air war consisted of three basic elements: attacks against North Vietnam, interdiction of communist supply lines in Laos and Cambodia, and support for ground forces in South Vietnam. Each element saw tactical successes and technological innovation but ultimate strategic defeat.

The theater air effort lacked unity of command. In 1965, Southeast Asian air assets were under Thirteenth Air Force, subordinate to Commander, Pacific Air Forces. The 2d Air Division in Saigon controlled operations in South Vietnam and reported to Commander, U.S. Military Assistance Command, Vietnam (COMUSMACV). The Seventh Fleet's Task Force 77—subordinate to Commander in Chief, Pacific Fleet (CINCPAC)—controlled carriers in the Tonkin Gulf. In 1966, the 2d Air Division became the Seventh Air Force, whose commander chaired the Air Coordinating Committee that allocated targets and radio frequencies. CINCPAC divided North Vietnam into seven areas, or "route packages," in which the USAF and Navy conducted relatively separate, uncoordinated campaigns.

The air war depended critically on aerial refueling. B-52s required "tanking" on 12-hour flights from Guam, and tactical aircraft demanded pre- and poststrike refueling. Tankers frequently flew into North Vietnam to refuel desperate aircraft; none were ever lost to enemy action. Boeing KC-135 numbers rose from 55 in 1965 to 94 in 1969, with 172 in-theater for the 1972 LINEBACKER operations. In nine years, Strategic Air Command KC-135s flew 194,687 sorties and made 813,878 refuelings.

The war over North Vietnam consisted of several operations: ROLLING THUNDER (March 1965–November 1968), LINEBACKER (March–October 1972) and LINEBACKER II (18–29 December 1972). ROLLING THUNDER began in reprisal for Viet Cong attacks on U.S. airbases in South Vietnam. Strict Rules of Engagement (ROE) governed operations, though ROE gradually loosened as the war progressed. ROE defined areas near Hanoi, Haiphong, and the Chinese border as "sanctuaries"—where North Vietnam naturally built airbases and surface-to-air missile (SAM) sites. U.S. President Lyndon Johnson tightly controlled target selection. His insistence on graduated escalation and clear weather missions made U.S. attacks predictable and increased losses. ROE prohibited attacks on certain targets, such as North Vietnam's irrigation system. MiGs could not be attacked without visual identification, which negated U.S. long-range air-to-air missile advantages and allowed MiGs to hide in clouds.

The USAF relied heavily on older aircraft (the North American F-100D/F, Lockheed F-104C/D, Republic F-105D/F, and Convair F-102A), the Navy on Douglas A-4s. Improved North Vietnamese defenses, including SAM batteries, eventually required employment of newer aircraft (McDonnell F-4C/D/Es and Grumman A-6s) on missions over the North, and many support aircraft, such as RF-4Cs, Douglas EB-66B/Cs, McDonnell RF-101Cs, and Lockheed EC-121s, participated in each mission.

Hanoi's air defenses consisted of radars, antiaircraft (AA) guns, SAMs, and MiGs. In 1965, Hanoi had about 1,500 AA guns; the number rose to 8,050 in 1968. Many were radar-controlled and fired proximity shells. AA accounted for 85 percent of aircraft downed in ROLLING THUNDER. By 1968, Hanoi had several hundred SA-2 SAM batteries that forced aircraft down into AA gun range and required Americans to fly jamming and suppression missions. Hanoi had about 30 fighters in 1965 and 75 in 1968. By 1972, Hanoi had 93 MiG-21s, 33 MiG-19s, and 120 MiG-17s. Under rigid ground control, these small, highly maneuverable fighters armed with cannons and (on MiG-21s) two to four Atoll heat-seeking missiles intercepted U.S. strike missions. MiGs used hit-and-run tactics, attacking at supersonic speeds through U.S. formations and firing a missile before escaping. U.S. aircraft were often forced to jettison their bombs, after which they could rarely catch the nimble MiGs.

ROLLING THUNDER focused on interdiction. Nearly 90 percent of the bombs struck transportation targets (roads, rail lines, and bridges). In 1966, emphasis briefly shifted to POL (petroleum, oil, lubricants), and 65 percent of Hanoi's storage sites were destroyed. In late 1966 and early 1967, industries, power stations, and military airfields were attacked. In 1968, air commanders requested intensified attacks in response to the Tet Offensive, but antiwar clamor at home forced Johnson to cancel attacks on North Vietnam on 31 March. In total, the United States dropped 643,000 tons of bombs but failed to hinder significantly Hanoi's war effort. Communist supply needs in South Vietnam were minimal, and North Vietnam required only negligible amounts of POL and electric power. China and the Soviet Union supplied ample weapons and equipment, and Johnson refused to close these supply routes. In short, U.S. planners overestimated airpower's ability to win the war and underestimated Hanoi's will to fight.

LINEBACKER I sought to halt Hanoi's 1972 invasion of South Vietnam. Air reinforcement of Southeast Asia commenced in February. Hanoi's invasion began on 30 March, and B-52s hammered enemy troop concentrations. F-4Es, F-105Gs, RF-4s, and EB-66s reinforced Southeast Asia from Korea, Japan, and the United States, and six carriers deployed in the Gulf of Tonkin. By June, the USAF alone had some 752 aircraft in-theater, including 393 F-4s, 172 KC-135s, and 138 B-52s. In May, President Richard Nixon authorized air attacks throughout North Vietnam and the mining of harbors.

B-52s smashed North Vietnamese airfields below the 20th Parallel, and F-4s suppressed SAMs. F-4s struck interdiction targets around the clock, and the use of laser-guided bombs freed more aircraft to fly escort. MiGs were effective until the USAF created the Teaball Weapons Control Center in August to provide pilots with combined radar and intelligence information. USAF kill ratios then climbed from 1:1 to 4:1. During LINEBACKER, 155,548 tons of bombs hit North Vietnam. Bridges, oil storage sites, docks, and power facilities were wrecked, and imports substantially declined. North Vietnam could not attack the South again until 1975.

In December, Nixon punished North Vietnam for its diplomatic intransigence. LINEBACKER II involved 729 night sorties against 34 targets with 206 B-52D/Gs. An additional 613 tactical strike and 2,066 support sorties were flown: EB-66s, EA-6s, and EA-3s jammed enemy radars, F-111s and A-7s struck airfields, F-4s and F-105s attacked SAMs, C-130s and HH-53s conducted search and rescue, and F-4s escorted, flew combat air patrol, and laid chaff. Hanoi's MiGs withdrew to China, but SAMs remained a threat. In total, 1,240 SA-2s were fired, downing 15 bombers (12 aircraft were lost to other causes). Rail traffic stopped, electric power generation fell 75 percent, and POL supplies fell 25 percent. More than 15,000 tons of bombs were dropped, but civilian casualties were minimal. Since Hanoi accepted Nixon's demands, LINEBACKER II was a clear victory.

The air campaign in Laos principally sought to interdict the Ho Chi Minh Trail, the primary targets being the thousands of trucks that used it. Roads, mountain passes, river fords, supply caches, AA sites, and troop concentrations were also hit. In 1965–1966, forward air controllers in O-1 observation planes located targets for tactical aircraft to strike. The enemy could soon move only at night and in bad weather yet still met the minimal needs of forces in South Vietnam. Attacks on roads were relatively easily repaired, although road maintenance eventually required 300,000–500,000 troops. Hanoi deployed some 700 AA guns to defend the Ho Chi Minh Trail.

The ineffectiveness of interdiction prompted installation of the Igloo White anti-infiltration system in 1967. Acoustic and seismic sensors in Laos beamed data to orbiting aircraft, which retransmitted the data to an assessment center in Thailand. The analyzed data enabled a C-130 airborne command center to direct gunships and fighters against targets around the clock. Unfortunately supplies still got through, and the Soviets quickly replaced destroyed trucks.

After operations over North Vietnam halted in March 1968, interdiction efforts in the Laotian panhandle intensified. Operation COMMANDO HUNT (November 1968–March 1972) dropped some 3 million tons of bombs on Laos, including massive B-52 strikes on the four mountain passes between North Vietnam and Laos. The USAF claimed large numbers of truck kills (9,012 in 1969, 12,368 in 1970), but the CIA argued that Hanoi had only 6,000 trucks total. Hanoi's ability to attack South Vietnam in 1972 demonstrated that COMMANDO HUNT failed.

In northern Laos, U.S. airpower supported the Laotian army and Hmoung guerrillas against communist forces, and the USAF established navigation sites on remote mountaintops. COMUSMACV controlled interdiction operations in southern Laos, but operations in northern Laos required coordination between the CIA, HQ Seventh/Thirteenth Air Force, and the air attaché in Vientiane. Ambassador William Sullivan micromanaged the effort through the attaché's office, and he frequently imposed absurd limits on air operations.

Nixon ordered strikes on six communist bases in Cambodia from March 1969 to May 1970. The Operation MENU bombings entailed 3,875 B-52 sorties that dropped 108,823 tons of bombs. The secret missions used strikes on South Vietnam as bureaucratic cover. The bombing significantly reduced enemy activity, but ground forces had to invade Cambodia in April 1970 to destroy the enemy bases completely.

When U.S. ground forces arrived in Vietnam in 1965, COMUSMACV ordered the USAF to give close air support (CAS) top priority. The 2d Air Division (later Seventh Air Force) Tactical Air Control Center (TACC) planned and coordinated the tactical air effort. The TACC allocated sorties to the Direct Air Support Center (DASC) in each corps area, and the DASC responded to CAS requests from units in the field. A combination of preplanned and dedicated alert sorties ensured that CAS was always quite plentiful. On an average day, 40 aircraft were on alert, and Seventh Air Force flew 300 sorties, 1st Marine Air Wing 200 sorties, and the South Vietnamese 100 sorties. Tactical aircraft based in South Vietnam and Thailand usually arrived on target within 35–40 minutes or within 15 minutes if diverted from elsewhere. Furthermore, COMUSMACV selected targets for B-52s that flew 1,800 sorties per month in South Vietnam. Nearly 4 million tons of bombs fell on South Vietnam from 1965 to 1972.

Two examples demonstrate the tremendous impact of CAS. During the 1968 siege of Khe Sanh, 24,000 fighter-bomber and 2,700 B-52 sorties delivered 110,000 tons of bombs. This smashed the North Vietnamese Army (NVA) and inflicted more than 10,000 casualties. In 1972, Hanoi attacked South Vietnam with more than 14 divisions and 600 tanks. One hundred thirty-eight B-52s and 247 tactical aircraft were immediately available, and hundreds of aircraft reinforced from around the world. Operational tempo was impressive: B-52 sorties rose from 689 in March to 2,223 in May, fighter sorties from 4,237 in March to 18,444 in May.

This enabled the shaky South Vietnamese Army to defeat the NVA and inflict 75,000–120,000 casualties.

James D. Perry

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Soviet Air Force

In Western countries, typically known as the Red Air Force—one of the largest and most powerful air forces of the twentieth century. The rise and fall of the Soviet air force (1918–1991) reflected Soviet military might yet contributed enormously to the history of airpower.

The huge continental landmass and open areas of the Soviet Union, as well as the primacy of the ground forces in the structure of its military machine, defined air defense and ground support as the primary missions of aviation. The air force necessarily interacted with other independent airpower branches (air defense aviation and naval aviation) and undertook wider interservice coordination. Rapid expansion of the air force was driven mainly by the strategic ambitions and mobilization abilities of the communist regime and was supported by virtually unlimited resources. The air force accumulated broad experience, which greatly enhanced its operation, from the 1917 Russian Revolution through the Cold War.

The Bolshevik government inherited a shattered czarist air force. The progress of the civil war, which lasted from 1918 to 1920 and resulted in Lenin's rise to the pinnacle of power, as well as the Allies' intervention in Russia, forced the Bolsheviks to organize the Red Army, including an air arm. On 24 May 1918, the Chief Administration (Directorate) of the Workers' and Peasants' Red Air Fleet was organized. Simultaneously, regular Red Army air units were formed. Red Navy aviation existed in 1918–1920 as a separate service.

The rapidly changing pattern of the civil war, as well as the need to employ aircraft throughout diverse climatic and terrain conditions, posed daunting operational problems. Moreover, the air force suffered from extremely poor maintenance, logistics, and critical shortages in fuel, trained personnel, and spare parts (about 60 percent of the planes were of Western origin—Morane, Nieuport 17C.I, SPAD S.VII).

Although the air force conducted 17,377 combat sorties during the war and confronted some 635–770 enemy planes (White Russian, Allied, Ukrainian Nationalist, and Polish), air-to-air combat was somewhat rare, with only 131 engagements and 20 victory claims. Most of the effort was in ground support, bombing, and reconnaissance.

During World War I, the air force acquired significant operational and organizational experience that influenced its development. These included the value of highly centralized command and control, the use of airpower in mass, the value of interservice coordination in combined and joint operations, and some tactical innovations such as air assault on large cavalry formations and the use of aircraft in propaganda.

While previously relying on Western designs, the Soviets began building their own, such as the MK-21 Rybka naval fighter and I-1 and I-2 monoplane fighters. During the 1920s, two main design bureaus, led by Nikolai Polikarpov and Andrei Tupolev, emerged. The Soviets also benefited from the joint Soviet-German air training base in Lipetsk and particularly from Junkers production of all-metal monoplanes in Russia.

The first Five-Year Plans triggered a massive buildup of Soviet aviation, including many airplanes of indigenous design. Among them were maneuverable fighter biplanes, such as the Polikarpov I-15 and I-15 *bis;* the first cantilever monoplane with retractable landing gear to enter squadron service, the Polikarpov I-16; and a variety of bombers, including the Tupolev TB-7, SB-2/SB-3, and DB-3. Yet the Soviets failed to develop a reliable long-range bomber force. The established Soviet concept of air warfare envisioned the use of airpower predominantly in close support missions and under operational control of the ground forces command.

The Red Army Air Force under the command of Yakov Alksnis during 1931–1937 developed into a semi-independent military service with a combat potential, good training, and a logistics infrastructure spreading from European Russia into Central Asia and the Far East. Still, the Red Army Air Force exhibited marked deficiencies in several local conflicts (e.g., against the Chinese in 1929 and in the Spanish civil war, 1936–1939). In contrast, during the 1937–1939 air conflicts with Japan (China, Lake Khasan, Khalkin Gol) the Soviets effectively challenged the Japanese air domination and provided decisive close air support in the campaigns on Soviet and Mongolian borders. During the Winter War with Finland (1939–1940), however, the Red Air Force suffered heavy losses due to inflexibility of organization, its command-and-control structure, poor training of personnel, and deficiency of equipment.

The failures in Soviet airpower were reinforced by the terror of Stalinist purges. About 75 percent of the senior officers were imprisoned or executed, and some 40 percent of the officer corps was purged. The result was the critical decline of experience, initiative, and responsibility within the command of the air force and its combat personnel.

This decline was manifested in the initial phase of World War II. During the first six days of the German invasion in June 1941, the Luftwaffe wiped out 3,800 Soviet aircraft (most of them on the ground) and gained almost unrestricted air supremacy. The sporadic Soviet retaliatory strikes were poorly coordinated and led to devastating losses in aircraft and combat personnel.

But the highly centralized Soviet aircraft industry was relocated eastward. By the end of 1943, it resumed output of new types of aircraft to challenge the Germans. During the war, the Soviets produced about 137,000 aircraft. Among the new types were the MiG-3, LaG-3, and La-5 fighters and the Petlyakov Pe-2 bomber. Most important of all was the famous tank-killer—the Ilyushin Il-2 ground support aircraft, which Stalin said the Soviet soldier needed more than "bread and air."

The United States and Britain also supplied about 20,000 aircraft. Allied aid was of particular importance in 1942–1943, when Soviet aircraft production grew slowly. Some U.S. and British models influenced the work of Soviet designers.

In 1942 under General Aleksandr Novikov, the whole command-and-control system of the Red Army Air Force was radically centralized. The air units were withdrawn from direct operational control of the ground forces command and grouped into 17 air armies. These were attached temporarily to the fronts as well as to Long-Range Aviation Command and strategic air reserve.

These innovations enhanced the ground support role of Soviet military aviation, allowing it to mass airpower rapidly and decisively during all major operations on the Eastern Front. Additionally, it gave more flexibility to the air force command to conduct independent air operations. During the war, the Red Army Air Force performed some 3.125 million sorties and claimed 57,000 enemy planes shot down. Naval aviation claimed to have sunk 2 million tons of enemy shipping.

The professional skills of Soviet pilots as well as the combat and technical characteristics of the aircraft improved. Lieutenant Colonel Ivan Kozhedub had the final score of 62 aerial victories, which qualified him as the most successful Allied pilot of World War II. The contribution of Soviet airwomen was unprecedented in history (with three all-female air regiments). Junior Lieutenant Lydia Litvyak, with 12 confirmed victories, became the most successful woman fighter pilot in the world.

Despite Soviet air dominance during the last years of the war, there was nothing resembling the Anglo-American strategic bombing campaign in Europe. Small-scale strategic raids performed by long-range aviation on Berlin, Budapest, Constanta, Ploesti, Danzig, Königsberg, and other Axis targets revealed the lack of experience of Soviet pilots and problems in navigation.

The strategic and technological realities of the postwar world (the growing confrontation with the West, the invention of the atomic bomb, and the introduction of jet engines) shaped the development of the air force, which was reconstituted in 1946 as a fully independent armed service. Additionally, the Soviet concerns about the Anglo-American strategic air preponderance impelled the development of Soviet Air Defense (1954) into an independent service with a formidable air arm.

The study of German jet engines helped the Soviets develop their first jet fighters (in 1946, the MiG-9 and Yak-15 were introduced). At the same time, Soviet designers benefited from the wartime acquisition of several U.S. B-29 bombers. The strategic bomber force was reorganized in 1946 within the Soviet Air Force, equipped with Tu-4 heavy bombers (based on the B-29 design) and Il-28 medium bombers.

During the Korean War (1950–1953) the Soviets sent one air corps with three divisions, one separate night-fighter regiment, and a naval aviation regiment as well as the air defense and support units to fight the UN air force in Korea and on the Manchurian border. The Soviets performed 60,894 sorties and lost 335 aircraft and 120 pilots. While the air force and air defense units effectively forced UN bombers to suspend daytime raids, in pure air-to-air combat the Soviet MiG-15s were outgunned and outmaneuvered by the U.S. North American F-86 Sabre fighters.

The Korean experience led the Soviets to emphasize maneuverability and interception capability in their jet fighters. In 1955, the first Soviet supersonic fighter, the MiG-19, was introduced. Since 1950, the first helicopters appeared within the transport aviation. Also in the 1950s, the Soviet Air Force advanced its bomber development. Since 1956, the Tu-20/95 Bear turboprop bomber became the mainstay of the Soviet strategic bomber force.

The progress of the Cold War since the 1960s, the development of nuclear, thermonuclear, and missile weaponry, as well as the development of entirely new technologies, prompted significant changes in the Soviet Air Force. The political and military leadership needed a world-class airpower to back up rising global ambitions and be able to participate in any number of contingencies—nuclear and conventional. At the same time, the greater emphasis on ICBMs in the development of strategic power allowed the Soviets to reduce a number of obsolete aircraft without lowering the combat capability of its air force.

From the 1960 to the 1980s, the Soviets modernized their fleet of strategic bombers and introduced the supersonic Tu-22 bomber (1963). Beginning in 1987, the Tu-160 strategic bomber entered service. This bomber force was an integral (although the smallest) part of the Soviet strategic triad. Additionally, air-to-surface cruise missiles enhanced the strategic function of these aircraft. The cruise missiles, as well as the introduction of the Tu-26 longer-range bomber, in 1974 gave the Soviet Air Force the ability to carry out deep strikes across Western Europe, the North Atlantic, and North America.

As for Soviet tactical aviation, an increasing number of attack aircraft (MiG-21/-23s; Sukhoi Su-7/-9/-11s, and others) were introduced, strengthening the traditional interceptor/fighter-bomber priorities. During the 1970s, the Soviets put in service multipurpose aircraft (MiG-27s, Su-17/-24/-25s) with enhanced ground support and strike capabilities to fight in Europe and the Far East. One major innovation was the 1973 introduction of the Mi-24 attack helicopter—flying tanks—which became an increasingly important component of tactical aviation.

Transport aviation expanded its airborne and long-range airlift capabilities with the new Antonov An-22, An-24, and An-26 and the Il-76. In the late 1980s, the heavy-lift An-124 entered service. The development of the Soviet blue-water navy, including the first aircraft carriers, led to the introduction of the V/STOL MiG-21, the Yak-36, as well as Kamov Ka-25 helicopters with antisubmarine warfare capabilities. Additionally, the air force expanded its contributions to the Soviet space program.

In 1980, a major reorganization of the air force's two main combat components—Long-Range Aviation and Frontal Aviation—took place. Five Strategic Air Armies comprising long-range, longer-range, and medium-range bombers were created, deployed in the European Soviet Union (three armies), Poland (one), and Siberia (one). The Strategic Air Armies, subordinated to the Soviet Supreme High Command, were to provide nuclear and conventional support for theater strategic operations. Additionally, the Moscow Air Army had the broader responsibility of oceanic and intercontinental operations.

The Frontal Aviation forces and the combat helicopter force (Army Aviation) organized into divisions, and independent units were assigned to the military districts in the Soviet Union and Soviet forces in Eastern Europe, Mongolia, and Afghanistan. The number of foreign interventions grew as well: Cuba during the Cuban Missile Crisis (1962), Egypt (1970–1972), and large-scale employment in Afghanistan (1979–1988). Additionally, Soviet pilots and instructors contributed to local air defense and participated in combat during wars in Vietnam (1965–1972), Angola (1975–1990), and Ethiopia (1977–1979). Although such interventions demonstrated the global projection capabilities of the Soviet Air Force and gained it ground support experience, they also revealed inadequacies in equipment, logistics, and organization, particularly in dealing with insurgencies.

By the mid-1980s, the air force had achieved its pinnacle of power. The strategic bomber force had about 670 aircraft. The tactical aviation had 6,000 ground attack, air combat, and reconnaissance aircraft and some 3,500 helicopters. The transport aviation had 650 aircraft. Additionally, there were some 1,300 interceptors in the air defense air arm. Soviet naval aviation added 1,100 aircraft and helicopters.

The development of the Soviet Air Force, particularly its enormous modernization during the 1960–1980s period, could not change the weakness and fundamental disadvantage of the underlying Soviet system. Generally, Soviet military philosophy envisaged a heavy reliance on numbers rather than on training, technology, flexibility, and innovation. The emphasis on a highly centralized command-and-control structure was sometimes effective, but it also limited pilot initiative, especially as to air warfare, one of the most individualized arts in the military.

Despite modernization efforts, most of the Soviet Air Force lagged behind NATO airpower in electronics, navigation systems, precision munitions, maneuvering, fighter-escort abilities, and other key aspects of air warfare. By 1985, some 35 percent of Soviet combat aircraft were obsolete. Moreover, long-standing weaknesses in logistics, maintenance, and repair meant that Soviet aircraft became obsolete faster than did their Western counterparts. Additionally, the failure to fulfill the potential of aerial refueling for the Long-Range Aviation forces weakened maneuverability and strategic strike capability. Maneuverability of airpower was also hampered by slow development of the Soviet aircraft carrier.

Although the Soviet Air Force has traditionally been strong in the ground support and interception abilities, its overreliance on ground command and control inevitably limited the combat flexibility of air units, as well as initiative among pilots.

Moscow's Cold War strategy forced the Soviet Air Force to enter a hopeless competition with the strongest, ablest, and the most dynamic airpower the world had ever known. As the Soviet Union fell into the dustbin of history during 1991–1992, so too did the Soviet Air Force.

Peter Rainow

See also

Chkalov, Valeriy Pavlovich; Commonwealth of Independent States; Finland, and Air Operations During the "Continuation War"; Gagarin, Yuri; Imperial Russian Air Service; Khalkin Gol Air Battles; Khomyakova, Valerya; Khryukin, Timofei T.; Korean War; Kozhedub, Ivan; Kuban Air Battles; Kursk, Battle of; Kutakhov, Pavel; Litvyak, Lydia; Novikov, Alexander Aleksandrovich; Pokryshkin, Alexandr; Rudenko, S. I.; Safonov, Boris; Smushkevich, Yakov "General Douglas"; Sokolovsky, Vasily Danilovich; Soviet Volunteer Pilots; Soviet Women's Combat

Wings; Stalingrad, Battle of; Sutyagin, Nikolai; TsAGI; Warsaw Pact Aviation; Winter War

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Soviet Aircraft Development and Production

Long shrouded in government secrecy, the Soviet aviation industry and its output became better known in the 1990s as historical records and existing aircraft became available to Westerners. The rapid ascension of Soviet aviation—despite the many roadblocks it faced—is simply an amazing story.

The Russian aviation industry first emerged in 1910–1912, with many small plants producing a handful of aircraft. Virtually all of wood construction, about 270 aircraft were produced in the final year before World War I (1913). Some plants built French types under license; virtually all aircraft engines were imported or assembled from imported parts, as the country lacked the necessary metallurgical skills.

Despite the small number of aircraft manufactured, some degree of specialization was already evident, including reconnaissance aircraft, fighters, and bombers. The most famous early Russian designer was Igor Sikorsky, whose trend-setting work with large aircraft gained worldwide attention. When the war began, there were about 250 operational aircraft on hand. During the war, Russian plants produced about 5,500 aircraft, mainly Western models built under license.

Following the November 1917 Bolshevik takeover in Russia, the aviation industry was nationalized (mid-1918), though many of its best people fled during the resulting civil war (1918–1921). The revolution had devastated industry installations, and manufacturing virtually disappeared. By the early 1920s, the country's leadership faced many priorities: reestablishing industry, training personnel to manufacture and to fly, and, biggest of all, how to make sufficient aero engines. The Soviet Union's science and industry needed to develop as it made use of imported aircraft as well as abandoned leftovers from the Allies' ill-fated 1918–1920 intervention.

The first mass-produced Russian aircraft was the R-1 (Reconnaissance), of which some 2,800 had been manufactured by the time construction stopped in 1931. This was also the first Russian aircraft to be exported (to countries in the Middle East). The U-1 (Utility) was based on the Avro 504 and used for training—some 700 had been made by the early 1930s. The first domestic fighter aircraft, the I-2 (Grigorovich), was serving with the air force by 1925.

At this point, aviation became part of the larger industrialization trend in successive Five-Year Plans. The first (1928–1932) and second (1933–1937) helped to organize the industry, weeding out some weak performers. The third (beginning in 1938) saw more of a focus on modernizing aviation, based on the poor performance of Soviet aircraft in the Spanish civil war. Although many new aircraft were designed, not many actually entered production. Part of the problem was the sweep of the Stalinist political purges of 1938–1940, which detained many of the key designers (Konstantin Kalinin was killed).

Most of the famous Soviet design bureaus first appeared during the interwar period (though many designers had been active earlier), including Beriev (1932), which focused on flying boats; Ilyushin (around 1937); Kalinin (1925–1940, focusing on transports); the MiG team (1939); Polikarpov (1937), who focused on fighters (his I-15 biplane began series production and some 3,000 of all models made in 1934–1939); and Sukhoi (1939). Perhaps the most famous, Tupolev, began in 1922—his output, according to some sources, included more types of diverse aircraft than any other designer in history. Early Tupolev aircraft included the ANT-4, the world's first all-metal two-engine monoplane bomber produced from 1929 to 1932 and in service until 1936 (one flew from Moscow to New York by means of the Far East in 1929), the huge four-engine ANT-6, which first flew in 1930 and entered production as the TB-3 with more than 800 made. Many consider this heavy bomber to be the first Soviet aircraft to surpass the rest of the world. Yakovlev's bureau began in 1934.

World War II caught Soviet aviation unawares—more than 1,200 aircraft were lost on the first day of the Nazis' June 1941 invasion. For the next 6–8 months, aircraft and other factories were shifted eastward to the Urals and Siberia, a huge undertaking largely completed by early 1942. Relocation made transport of finished aircraft to the fronts more difficult, but by late 1942 and in 1943 Soviet aircraft began to appear in huge numbers. Germany's output was exceeded in 1943. Fighters such as the Yak-3 and Yak-9 (more than 16,000 of the latter), Lavochkin La-5 (10,000), and La-7 (nearly 6,000) began to take a toll on German air strength. The Ilyushin Il-2 attack plane was the most-produced plane in the war (1,000 made every month after 1942 for total of over 36,000), and the later Il-10 reached production numbers of 5,000.

The Soviets also copied major U.S. designs such as the DC-3 transport (Li-2) and B-29 bomber (Tu-4). The latter was accomplished by reverse-engineering some 105,000 pieces from U.S. aircraft that landed in the Soviet Union in mid-1944. About 900 had been produced by 1951. The Antonov design bureau appeared in 1945.

Postwar production was dominated by Cold War concerns and focused on a quick conversion to jet fighters. The first Soviet types appeared in 1946 (Yak-15 and MiG-9), and the twin-engine Tu-14 and Il-28 jet bombers were flown by 1947–1948. The MiG-15 was the first Soviet jet to see combat, in Korea. The MiG-19 (1954) was the first mass-produced Soviet supersonic aircraft. Through the 1980s, several Soviet design bureaus produced ever-more effective supersonic fighters and bombers at the cutting edges of technology. Late-model MiG and Sukhoi fighters serve in many countries' air forces today.

During the Khrushchev era (1957–1964), the Soviets focused on missiles and air defense rather than strategic and tactical aircraft. Tactical aircraft saw a resurgence only in the late 1960s and included new work on helicopters. Based on prototypes dating to 1940, Soviet helicopters rapidly progressed. The Mil (1947) and Kamov (1948) bureaus focused on helicopters, though Yakovlev and other designers also participated. Beginning in the late 1960s, production runs of some models rose into the thousands given Soviet and Warsaw Pact needs.

Many Soviet aircraft served both military and civil masters. The archaic-looking but widely produced single-engine propeller An-2 biplane transport (perhaps 20,000 produced) first appeared in 1947 and was still in use at the turn of the century. The Soviets' pioneering jet transport, the Tu-104, appeared in 1956 and was based on the earlier Tu-16 bomber; likewise the huge Tu-114 turboprop transport of 1957 was based on the Tu-95 bomber. Yakovlev and Ilyushin joined Tupolev in the transport market, producing a variety of propeller and jet airliners. The long-running Russian theory that bigger is better continued with the production of nearly 100 copies of the 1982 An-124 Ruslan, the largest aircraft in quantity production, and its unique larger sister, the 1988 six-engine An-225 Myiya, the world's largest aircraft. The Soviet Tu-144 supersonic transport was the world's first to fly in 1968, two months before the Concorde, although this Tupolev craft served only briefly with Aeroflot.

Today the former member states of the Soviet Union are in economic disarray, which inhibits production of new types. Research continues, albeit at a limited level.

Christopher H. Sterling

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Soviet Volunteer Pilots

Soviet pilots often participated in foreign military conflicts without official government involvement. The dispatch of volunteer Soviet airmen to assist allies and revolutionary forces was a regular practice from the beginning of the Soviet state. It allowed the Soviets to intervene on a limited scale without risking a wider conflict and provided the chance for practical tests of new tactics and equipment.

Soviet airmen were first sent to assist the Mongolian communists in their war against the Whites in June 1921 when Lenin sent a unit of four aircraft and crews that operated for several months before returning home. In October 1936, the first of several hundred Soviet volunteer aviators arrived in Republican Spain with the dual task of combating the Nationalist air forces and training the Republicans to fly Soviet aircraft.

Soviet pilots nominally camouflaged their presence by wearing Spanish uniforms and using noms-de-guerre, such as Pablo Palancar, Captain Jose, and General Douglas and generally stayed for about six months. The Soviets flew in squadrons integrated with Spanish and international volunteer pilots as quickly as they could be prepared to handle the modern Soviet equipment. Even before the Soviet withdrawal in October 1938 in the face of Republican defeat, Spanish pilots were being phased into command of the squadrons.

In October 1937, the Soviets again dispatched volunteer pilots, this time to assist the Chinese government against the Japanese, four fighter and two bomber squadrons initially being sent. Soviet pilots flew in China until 1939, and a few advisers remained through 1941. Though the number of aircrews dispatched is unknown, 1,250 aircraft were sent for use by Soviet volunteers and Chinese pilots, and during 1938 they provided the core of Chinese air defense.

From November 1950 to July 1953, Soviet pilots "performed their international duty" over North Korea. Their presence was officially denied, and the pilots wore Chinese uniforms. They flew about three-quarters of the communist air sorties and scored an even larger proportion of the air victories.

During the Cold War Soviet pilots occasionally participated in foreign air wars, including a clash with the Israeli air force over Egypt in 1970. During the Vietnam War, Soviet pilots were sent to North Vietnam as advisers and instructors and, on a number of occasions, unofficially flew combat missions, scoring victories that were credited to Vietnamese units.

George M. Mellinger

See also

Fighter Air Corps; Pepelyaev, Evgenii Georgievich; Smushkevich, Yakov "General Douglas"; Spanish Civil War; Sutyagin, Nikolai

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Soviet Women Pilots

Soviet airwomen achieved a historic record in service to their country.

Tamara Fedorovna Konstantinova was a senior lieutenant and deputy commanding officer, 999th Ground Attack Regiment/277th Ground Attack Division/First Air Army/3d Baltic Front. She was awarded the Hero of the Soviet Union on 29 June 1945.

Konstantinova was born in the Tver' region in 1919 and eventually became an instructor at the Kalinin Flying Club (Tver') in 1939. After war began, she was rejected for service at the front due to an alleged shortage of aircraft. She initially risked her life as a truck driver delivering ammunition. She then secured transfer to a communications subunit, where she flew the Po-2 and distinguished herself by evading German fighters. Upon joining the 566th Ground Attack Regiment in March 1944, she acquired a brand-new Ilyushin Il-2. She and her air gunner, Aleksandra Mukoseyeva, formed a cohesive and effective team.

In December 1944, she became deputy squadron leader after transferring to 999th Ground Attack Regiment. In West Prussia alone Konstantinova flew at least twice as many missions as other pilots did in a comparable period, maintaining she was fighting for two: her late husband and herself. By March 1945, Konstantinova had flown 66 operational missions and earned many decorations. After the war she flew light passenger aircraft out of Voronezh. In 1948, she was seriously injured during an emergency landing and permanently grounded.

Anna Aleksandrovna Timofeyeva (née Yegorova) was senior lieutenant and chief navigator, 805th Ground Attack Regiment/197th Ground Attack Division/Sixteenth Air Army/1st Belorussian Front. She was awarded the Hero of the Soviet Union on 6 May 1965.

Timofeyeva was born in the Tver' region in 1916. Upon graduating from the Kherson Flying School, she became instructor at Kalinin Flying Club (Tver'). At the beginning of the she war flew with 130th Independent Communication Squadron of the Southern Front. After a Messerschmitt set her unarmed machine afire, Timofeyeva became determined to fly combat aircraft.

She checked out in the Il-2 in early 1943 after flying only twice with an instructor, a difficult feat for such a complex aircraft. She received her baptism of fire over the Black and Azov Seas and soon became a skilled combat pilot and deputy squadron leader. She took part in fierce air battles over Taman' Peninsula and flew many missions in aid of Malaya Zemlya marines, attacking enemy tanks, ships, rail junctions, and airfields while coping with fatigue and heavy losses.

On 26 May 1943, she participated in voluntary laying of a smokescreen to enable ground troops to break through the enemy lines. Her daring was rewarded with decorations by the commander of Fourth Air Army himself.

After completing a two-month course for navigators in Stavropol, she received a new version of the Il-2. Dusya Nazarkina, formerly an armorer, became her gunner and rear set of eyes. When their wing reached the 1st Belorussian Front, Timofeyeva was appointed chief navigator. On 20 August 1944, during her 277th mission, she was shot down in flames east of Warsaw. In the Küstrin POW camp her life was saved by fellow inmates from both East and West. Upon release from the camp she was transferred to the reserves. Her 1965 Hero of the Soviet Union award was delayed by her internment in the POW camp.

Kazimiera J. Cottam

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Soviet Women's Combat Wings (1942–1945)

Soviet Women combat wings were founded in Engels, near

Stalingrad, by Marina Raskova, when male pilots were not readily available. They were organized as follows:

46th Taman' Guards Bomber Regiment. Wing Commander: Yevdokiya Bershanskaya. A component of 4th Air Army, initially designated 588th Bomber Regiment. The unit remained all-female throughout the war, being equipped with U-2 biplanes (These were renamed Po-2 in 1944 in honor of their creator, N. Polikarpov). Originally a trainer, they were converted for short-range night bombing and flown by a two-woman crew.

The 46th was operational in May 1942 and by mid-1943 consisted of four squadrons, including a training unit. It operated in Ukraine, Caucasus, Crimea, Belarus', Poland, and Germany. The unit made more than 24,000 sorties and produced about 25 Heroes of the Soviet Union.

125th "M.M. Raskova" Borisov Guards Bomber Regiment. Wing commanders: Marina Raskova and Valentin Markov. The unit was subordinated to Fourth, Sixteenth, and Third Air Armies. It was initially designated 587th Bomber Regiment and comprised of two Petlyakov (Pe-2) dive bomber squadrons. The aircraft were equipped with five machine guns. The aircrews consisted of pilot, navigator-bombardier, and radio/operator-gunner (the last were mostly men, initially). Technical personnel also included men. The 125th went into action near Stalingrad then operated successfully over North Caucasus (hence honorific of "M.M. Raskova"), Orel-Bryansk sector, Smolensk, Belarus, the Baltic, and East Prussia. The 1134 medium-range sorties it delivered produced five Heroes of the Soviet Union.

586th Fighter Regiment. Wing commanders: Tamara Kazarinova and Aleksandr Gridnev. Using Yak-9 fighters, its personnel protected industrial centers, rail junctions and bridges in Saratov, Voronezh, Kastornaya, Kursk, Kyiv, Zhitomir, Budapest and Vienna. One squadron, including the future aces Lidya Litvyak and Yekaterina Budanova, was sent to Stalingrad. The unit included some male technicians and fighter pilots.

The 586th was not without problems. Aleksandr Gridnev alleged that Kazarinova had contributed to several unnecessary deaths of subordinates. In addition, after her transfer to Moscow's Air Defense HQ; he held her responsible, for the wing's apparent mistreatment by the authorities.

Kazimiera J. Cottam

See also

Litvyak, Lidya; Raskova, Marina Mikhaylovna

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Soyuz Space Vehicle

Soviet space program; the third step toward putting a cosmonaut on the moon, it ended up as a standard orbital vehicle used to service Salyut and later Mir stations. Following automatic testing in 1966 as a Cosmos mission, the Soyuz 1 manned spacecraft orbited earth on 24 April 1967, with Vladimir Komarov onboard. Tragically, the parachutes slowing the capsule's descent to earth (the Soviets landed their craft on earth rather than water) tangled, and Komarov died on impact.

The program was halted for 18 months and resumed in October 1968 with a rendezvous (but no docking) between the automated Soyuz 2 and a single-manned Soyuz 3. Soyuz 4 and Soyuz 5 in January 1969 docked, and two of the three men in Soyuz 5 joined the Soyuz 4 pilot via extravehicular activity for return to earth. Meanwhile, five missions using the Soyuz spacecraft under the Zond program were used to gain experience about lunar orbit.

By then, the United States had won the moon race. While the United States concentrated further on the Apollo program, the Soyuz program was reworked into an orbital program and used to service first the Salyut space stations and later Mir. Another tragedy struck the Soyuz program, however. On 29 June 1971, Soyuz 11 returned from a record 24-day mission aboard station Salyut 1 when an improperly closed valve vented the capsule's oxygen, asphyxiating all three cosmonauts, who were not wearing their pressure suits due to space limitation. Consequently, Soyuz 12 was cancelled and Salyut 1 was abandoned in orbit. From then on, only two-man crews in full pressure gear were allowed to fly until the modified Soyuz T entered service in 1980. This also meant that Salyut mission times would be cut by more than 30 percent. Thus, the Soyuz 11 record would not be broken until 1975. Other Soyuz missions did fail, but not so spectacularly. Soyuz 18, for example, failed to achieve orbit and plunged back to earth, injuring its occupants. The Soyuz 18B had to be prepared in a hurry to service station Salyut 4, which needed supplies.

Meanwhile, following the 1972 U.S.-Soviet effort at détente, a modified mission, Soyuz 19, was prepared for orbital linkup with an Apollo command module. A modified capsule was thus launched in April 1975 for the symbolically important Apollo-Soyuz Test Project. Other modifications to the Soyuz program included the development of a simplified capsule, Progress, for resupply of a space station. Cosmonauts piled garbage into it and dispatched it into the atmosphere, where it burned up. The last original Soyuz design was Soyuz 40 and flew in 1981. It was then replaced by the improved Soyuz T, which routinely serviced Mir until the station was abandoned in 2001 and now serves as a shuttle alternative in reaching International Space Station Alpha.

Guillaume de Syon

See also

Apollo Space Program; Salyut

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Spaatz, Carl Andrew (1891–1974)

One of the major personalities behind the independent United States Air Force; the first USAF Chief of Staff. Carl A. Spaatz commanded Eighth Air Force and U.S. Strategic Air Forces Europe during World War II. As commander of Eighth Air Force, Spaatz supervised the massive B-17 and B-24 bombing campaign over Germany in 1942.

The results of that campaign, as well as a recommendation from close friend General Henry "Hap" Arnold, U.S. Army Air Forces commander, led to his selection by Dwight D. Eisenhower as air commander for Operation TORCH in 1942 and Operation OVERLORD in 1944. He was the only U.S. commander to be present at the surrenders of both Germany and Japan, having been transferred to the Pacific Theater to oversee air operations, including the atomic bombings at Hiroshima and Nagasaki.

On 2 February 1946, Spaatz succeeded Arnold as commander of U.S. Army Air Forces. He headed the U.S. Air Force as its first Chief of Staff from 26 September 1947 until his retirement on 30 April 1948. From 1948 until 1961, Spaatz contributed a military affairs column to *Newsweek* magazine and served as a member of the board of defense contractor Litton Industries. He died in Washington, D.C., and is buried at the U.S. Air Force Academy, Colorado Springs.

Spaatz was a vocal proponent of strategic daylight bombing tactics—doctrine developed by his fellow alumni at the Air Corps Tactical School. He advocated an independent air force and spoke as a witness at Brigadier General William "Billy" Mitchell's 1925 court-martial. Along with Mitchell and Arnold, Spaatz is considered one of the founding fathers of the United States Air Force.

Kevin Gould

See also

Arnold, Henry H. "Hap"; Mitchell, William; U.S. Army Air Corps

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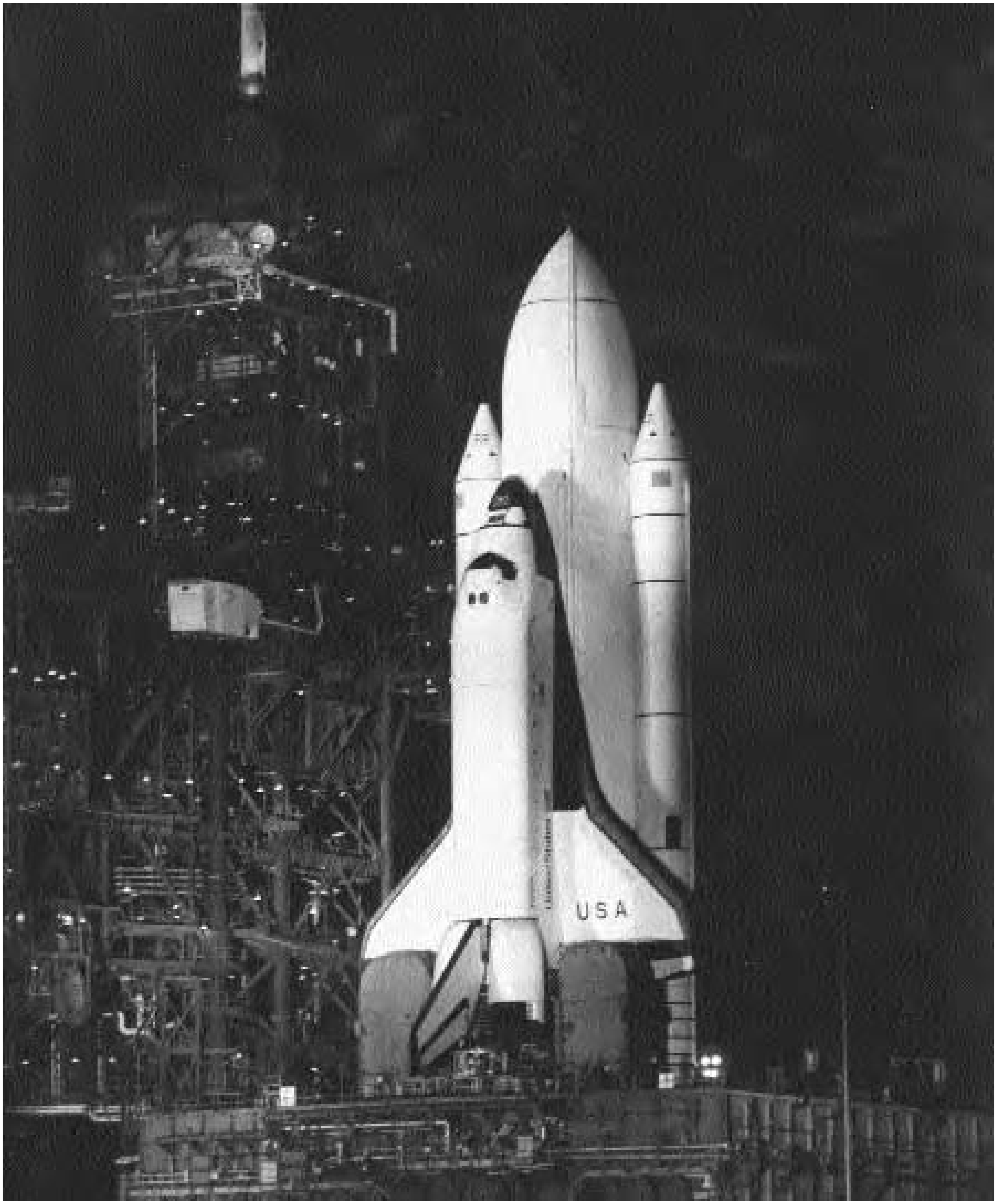
Space Shuttle, Military Use of

During the development of the Space Shuttle, NASA realized that it was critical to have the military's support when asking for funds from Congress. Although the Air Force did not particularly see an immediate need for the capabilities offered by the Space Shuttle, it agreed to provide political support in addition to some minor funding of its own. During 1982–1983, the Department of Defense (DoD) paid NASA a total of $268 million for nine dedicated military Space Shuttle launches. In addition, the Air Force agreed to construct a launch site at Vandenberg AFB, California, that would be capable of letting the Space Shuttle reach polar orbits—something it was unable to do from the Kennedy Space Center, Florida, without dropping the external tank on inhabited landmasses.

The first dedicated DoD mission was STS-20 (51-C) on 24 January 1985 using the orbiter *Discovery.* Only one other DoD mission (STS-28/51-J) would be flown prior to the 1986 *Challenger* accident. The two missions were by far the shortest operational missions flown by the Space Shuttle prior to the standdown, although the Air Force never officially acknowledged what payloads were carried on these missions.

During the standdown caused by the *Challenger* accident, the Air Force decided to move back to using Atlas and Titan expendable launch vehicles and cancelled the construction of the SLC-6 shuttle site at Vandenberg. However, the Air Force had already paid for seven additional missions and saw no reason not to take advantage of them. When the shuttle returned to flight in 1988, the Air Force began to fly its remaining missions; STS-27R, STS-28R, STS-33R, STS-36, and STS-39 would be dedicated DoD missions conducted under a veil of secrecy. One further mission, STS-53, would be launched in 1992 and would carry a small DoD payload but would not be conducted in secrecy. All major national payloads are currently launched on expendable launch vehicles.

Dennis R. Jenkins



Every Space Shuttle launch is a tremendous challenge. Here is the Discovery, *bathed in the Cape Canaveral spotlights. (Walter J. Boyne)*

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Space Stations

Permanent platforms in space design for prolonged human living and scientific experiments. Space stations have been a fundamental part of space exploration and research since 1971 when the Soviet Union launched the first of seven Salyut space stations. The development of space stations was the direction that both superpowers took after NASA landed astronauts on the moon in 1969.

Originally, Salyut was intended as a military station. Cosmonauts would conduct military experiments and assess the feasibility of military outposts in space.

Claiming that the moon was never their goal, the Soviets took the lead in building and launching space stations and hold the record for the longest flight by an orbited platform. The Mir Space Station spent a remarkable 15 years in orbit—five times longer than intended. Unfortunately, its last years were plagued by fire and a series of accidents, including a collision with an unmanned supply ship. The station was brought out of orbit over the Pacific Ocean in March 2001.

Mir was launched before the Iron Curtain was lifted, and control of the station was transferred to the new government in Russia. Perhaps the most incredible aspect of Mir was that it helped bring NASA and the Russian Space Agency closer as U.S. Space Shuttles docked with the station and Americans spent time aboard the Soviet craft.

The United States had a space station of its own in the 1970s. Skylab was launched by a modified Saturn V rocket in 1973 and spent the next six years orbiting the earth and playing host to three crews. Each crew spent more time in space than the last; Americans spent 4,116 hours, 50 minutes in this station.

The Alpha International Space Station has been the focus of 16 countries' space endeavors since 1998. Crews have already been sent to the station and will continue to occupy it until completion, scheduled for 2003. The station will serve as a research facility and may aid in future journeys to Mars.

Erich Streckfuss

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NASA. Official website. Available online at www.nasa.gov.

SPAD Aircraft

Early French aircraft. Originally the Société Provisoire des Aéroplanes Deperdussin (Deperdussin Airplane Company), the company's future was placed in doubt when founder Armand Deperdussin went to prison for fraud in 1913. New owners, including Louis Blériot, anxious to preserve the company's fortunes as well as its initials—which by that time had become very well known in aviation circles—changed the name to Société Anonyme pour l'Aviation et ses Derives (SPAD).

In the second half of World War I, SPAD aircraft equipped the air services of all the Allied powers, several thousand eventually being built. The SPAD VII represented the marriage of two outstanding designs: a Louis Bechareu airframe and Mark Birkigt's Hispano-Suiza eight-cylinder 180-hp V-8 engine.

The airframe combined a strong, wood-framed fuselage with single-bay biplane wings, the flying and landing wires braced at their intersection by an additional strut that gave the aircraft a two-bay appearance. Armament was a single Vickers gun.

The SPAD appeared in French escadrilles in 1916 and a pair of RFC squadrons the following year. The SPAD was the mount of the elite French unit, the four escadrilles that made up Les Cigognes (The Storks) of Combat Group 12. Enough were built that it fulfilled U.S. needs in 1918 as well. Though this model was not as well-armed as its successor, the SPAD XIII, the chronic engine troubles of the geared Hispano that powered the latter caused many to prefer the earlier model.

The SPAD XIII, which started appearing in September 1917, was essentially a scaled-up version of the SPAD VII, having a larger fuselage, tail surfaces, and wings, as well as a second gun and a more powerful engine. The different engine proved a problem for the Model XIII, however. The direct-drive 180-hp Hispano that had powered the Model VII was a reliable unit that caused few problems. The geared engine, though developing more horsepower, proved a maintenance nightmare. According to some reports, as many as 60 percent of SPAD XIIIs were out of commission due to engine problems at various times during the war. Had the war gone into 1919, it is likely the later-model SPAD would have been replaced.

In the summer of 1918, both single- and two-seat SPADs were sold to the United States Air Service, and on Armistice Day the SPAD XIII was the primary equipment of all but two U.S. fighter squadrons. On the morning of 12 September 1918, General William "Billy" Mitchell observed operation of the aerial armada he had assembled for the Battle of Saint Mihiel from the cockpit of the SPAD XVI that now hangs in the World War I gallery of the Unites States Air Force Museum.

James Streckfuss

The SPAD VII was a welcome replacement for the earlier Nieuport series of fighters, for while the Nieuports suffered from structural weakness, the SPAD was strongly built and capable of a good turn of speed. (U.S. Air Force)

See also
Birkigt, Mark
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Spanish Air Force

The Spanish air force was only two years old when it first saw combat during the Spanish-American War (1898). The original branch of the air force consisted of captive balloons and was known as the Servicio Militar de Aerostacio. Fixed-wing aircraft were integrated into the air force in 1911 with the establishment of the Aeronautica Militar Espanola (AME).

The next milestone was the onset of the Spanish civil war in 1936. Pitting the Republicans (socialists) against the Nationalists (fascists), the Spanish civil war is seen by many as a dress rehearsal for World War II. The Republicans received aid from Great Britain, France, Russia, Canada, and the United States; the Germans and Italians eagerly provided aid to the Nationalists. From the outset, the AME was split into a Republican air force and a Nationalist air force. However, the key players in the air war would in fact be the third parties. The involved air forces were in the midst of their evolution from the biplanes of World War I to the sleek monoplanes that would fill the skies during World War II. Of particular note was the combat debut of the Messerschmitt Bf 109 and the Junkers Ju 87 Stuka; both played key roles in Germany's 1939 blitzkrieg.

The lessons learned during the Spanish civil war would shape not only air combat tactics but also the design of many of the aircraft. In its wake, the civil war left Spain in no mood for further conflict, and thus the newly formed Ejército del Aire (EDA; Army of the Air) would sit out World War II from a position of neutrality.

The involvement of third parties in the Spanish air force continued throughout most of the Cold War. A 1953 agreement between Spain and the United States established the exchange of military aid for U.S. military facilities within the country. Key among those were the now-closed U.S. facilities at the air bases of Rota and Torrejón. The presence of U.S. fighters on Spanish soil allowed the Spaniards to train with many of the premier aircraft of the time, and the F-4 Phantom eventually became Spain's front-line fighter.

A continuous upgrade program over the last 40 years has shaped the modern EDA. The current front-line fighter is the McDonnell Douglas E/F-18 Hornet. This modern combat plane is capable of effectively filling both the air-to-air and air-to-ground roles. In addition, the EDA maintains stockpiles of the Harm antiradar missile and the Harpoon antiship missile, further increasing the versatility of the E/F-18. The EDA also maintains approximately 60 Mirage F-1s in the fighter-bomber role and two squadrons of SF-5s (Spanish-assembled F-5s) in the tactical-reconnaissance and light-bomber roles. Additionally, one squadron of RF-4Cs has been retained solely for tactical reconnaissance.

The future of the EDA lies in the delivery of the Eurofighter Typhoon. Spain holds a 13 percent interest in the repeatedly delayed project and has ordered 87 aircraft. When these airframes are finally delivered, they will become the premiere fighters in the EDA and will most likely assume many of the missions now filled by the E/F-18.

Troy D. Hammon

See also

Blitzkrieg; Boeing F/A-18 Hornet; Junkers Ju 52/3m, Ju 87 Stuka, and Ju 88; Messerschmitt Bf 109; Spanish Civil War

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Spanish Civil War

The 1936–1939 conflict in Spain between Republicans (socialists) and Nationalists (fascists); with the participation of several third parties, it became a proving ground for World War II air warfare.

Control of the air was one of the most important factors for the Nationalists in their victory. A week after the outbreak of rebellion on 18 July 1936, Nationalist emissaries approached German dictator Adolf Hitler in a desperate appeal for aircraft. Many of the best Nationalist troops were in Morocco, unable to get to Spain because the Republican government controlled the navy. The Nationalists wanted to purchase Ju 52 trimotor transports to ferry General Francisco Franco's troops to Spain. Hitler immediately loaned 10 Lufthansa Ju 52s and six Heinkel He 51 biplane fighters to provide protection. All had German aircrews. Beginning on 29 July, they flew 20,000 crack Spanish and Moroccan troops to Nationalist-controlled Seville in southern Spain. This was critical. Without it, the outcome of the war would have been different.

On 14 August, a Luftwaffe Ju 52 dropped two bombs on a Republican battleship, putting it out of action. Then in early November Hitler provided 10 Ju 52 bombers, and the German military presence in Spain grew steadily. Earlier aircraft were transferred to the Nationalist air force. The German presence was formalized in November 1936 as the Volunteer Corps, identified as Number 88 but popularly known as the Kondor Legion. It consisted of a bomber group, a fighter group, a reconnaissance group, a seaplane squadron, an antiaircraft group, and ground support elements. In all, its authorized strength was something less than 6,000 men and about 100 aircraft, but a total of 19,000 men and 300–400 planes served in Spain over the course of the war. These were not volunteers but regular German military units. A total of 298 members of the Kondor Legion died in Spain and 1,000 were wounded.

The best German bombers in Spain were two new twin-engine medium models: the Dornier Do 17 (the "Flying Pencil") and Heinkel He 111. In 1937, they replaced the Ju 52s, which were then turned over to the Nationalist air force. The Germans flew virtually all aircraft in the Luftwaffe inventory in Spain, including the Ju 87 Stuka dive-bomber. At first the main German fighter was the outdated He 51, but it was replaced beginning in 1937 by the Messerschmitt Bf 109, the best fighter in the war and one of the top fighters during World War II. Reconnaissance aircraft included the He 99 and He 70, He 59 and He 60 seaplanes, and one Ju 52 on floats.

The Germans used the conflict to the test these aircraft under combat conditions. Spain also provided a training school for the development of tactics, including the finger-four formation. This led to techniques like coordinating ground troops and tactical air assets that were to be devastatingly effective early in World War II. During the conflict, Kondor Legion pilots downed 380 Spanish Republican aircraft (56 to antiaircraft fire) against their own losses of 72 planes. An additional 160 German aircraft were lost to accidents.

Italy made a much greater commitment to the Nationalist side. As soon as dictator Benito Mussolini learned the Germans had sent aid, he sent a dozen transport aircraft. The world learned of the Italian intervention when, on 30 July 1936, two Savoia bombers on their way to Spain made a forced landing in Morocco and another crashed in Algeria. Mussolini ultimately sent 50,000 men and about a third of Italy's total armaments. The commitment was mostly in the form of ground units and nearly 2,000 artillery pieces, but it included 750 aircraft. Some 3,100 Italians died in the war (174 airmen). Despite its significant numbers, Italy's effort in Spain was nowhere nearly as effective as that of Germany.

The Spanish Republic's air force was quite small, but before London applied pressure on Paris, France had supplied the Republicans with 30 reconnaissance aircraft and bombers, 15 fighters, and 10 transport and training aircraft. Given the noninterventionist attitudes among major Western powers, Mexico and the Soviet Union became the principal suppliers of weapons to the Republicans. Soviet aid was purchased at market prices with 510 tons of Republican gold. Although no Soviet fighting units ever went to Spain, Soviet leader Joseph Stalin did send military equipment, including 731 tanks. In the air the Russians supplied some pilots, flying instructors, and 250 aircraft. This was clearly insufficient to save the Republican side.

German air cover and bombing was decisive in the outcome of the civil war. Kondor Legion units participated in all major Nationalist operations, and they were especially effective in blunting the last great Republic effort, the 1938 Ebro River Offensive. This and the terror-bombing of Spanish cities, especially Guernica, produced the false impression that airpower alone could win wars.

Spencer C. Tucker

See also

Dornier Do 17; Junkers Ju 52/3m, Ju 87 Stuka, and Ju 88; Messerschmitt Bf 109

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Special Operations

Special operations aviation has made strategic differences in warfare by providing the means to transport arms and create lines of communication to resistance groups, conduct precise attacks, and insert special operations forces. Misused by conventional-minded commanders, special operations airpower has often fallen short of the mark. Nevertheless, its successes demonstrate a remarkable capability for the cost.

The Royal Air Force first experimented with special operations in the form of air control, a plan to save money by policing the empire from the air. Air Marshal Hugh Trenchard argued the RAF could put down any revolt, and the first operational chance he got proved him correct in the eyes of the British government. Nine RAF de Havilland D.H. 9s working with the Camel Corps destroyed a rebel Somali force in 1919, paving the way for extensive further British use.

During World War II, the British advanced the concept following Prime Minister Winston Churchill's charge to "set Europe ablaze" with special operations. It was decided that the Resistance on the continent could be made into a viable force if they were dropped arms and given guidance. The U.S. Office of Strategic Services (OSS) joined British squadrons in late 1943 and, by mid-1944, supplied arms to resistance groups in Europe. "Carpetbagger" units flying from England and more OSS air units in North Africa and Italy helped armed resistance units to divert German forces. In the China-Burma-India Theater, U.S. Air Commandos took on the mission of long-range resupply to Allied forces. One such operation, Operation THURSDAY, infiltrated 9,000 men, 1,458 horses and mules, and 500,000 pounds of supplies more than 200 miles behind Japanese lines.

Despite this success, the United States virtually dismantled its own special-operations capability with the overall demobilization following World War II. By the time of the Korean War, it had to reinvent the wheel and labored under the constraints of conventional airpower thinkers.

Fighting the Vietnam War proved no less difficult and was often hampered by a lack of understanding and support from the U.S. Air Force, which was poised to fight a nuclear war with long-range bombers and faster and faster jets. Nevertheless, when energetically and imaginatively led, such forces made significant contributions by supporting friendly forces in Laos, Cambodia, and Vietnam against enemy forces. The units furthered psychological operations by dropping leaflets, using loudspeakers, and aiding in deceiving the enemy.

Again dismantling its special-operations capability, the United States found itself wanting during the 1980 Operation EAGLE CLAW and the Iran hostage rescue attempt. The result was the 1986 Goldwater-Nichols Act and the creation of United States Special Operations Command. The new command includes three service components: Air Force Special Operations Command (AFSOC); Army Special Operations Command (USASOC); and Naval Special Warfare Command (NAVSPECWARCOM). With a budget controlled by those who understand unconventional warfare, special operations aviation has matured into a significant force, providing surprise, speed, and purpose to unconventional warfare. When used in conjunction with conventional forces, it can achieve strategic indirection by maximizing resistance forces within the enemy's interior.

Benjamin F. Jones

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Speer, Albert (1905–1981)

The organizational genius behind Germany's World War II manufacturing output, especially the manufacture of fighting aircraft.

The son and grandson of architects, Speer earned an engineering degree at the Technical University of Berlin and began a private architecture practice. He joined the Nazi Party in 1931 and became a member of the elite SS a year later. He designed the dramatic lighting effects and settings for the Nazis' annual Nuremberg rallies of the 1930s and thus came to the attention of Adolf Hitler, who appointed him general architectural inspector of the Reich in 1937 with orders to redesign the city of Berlin. He soon became a favorite of Hitler, who shared an interest in architecture. In 1942, Speer was named the new minister of armaments and war production following the death in a plane crash of Fritz Todt. A year later, all of Germany's war production came under his direction, making him the virtual dictator of the German war economy. Thanks to his organizing efforts, German industry continued to produce even as Allied bombing grew more severe. Some historians suggest he helped to prolong the war by holding German war production together for so long.

But in his ministerial role, he was directly involved in Germany's extensive use of slave labor to keep the plants operating. He was the only senior German official at the postwar Nuremberg trials to admit his guilt. He was sentenced to a 20-year term for his role in the slave-labor program, served 20 years at Spandau Prison, and was released in 1966. He had secretly begun to write his memoirs while in prison, and after revision they were published in 1969. Recent studies have called into question some of his more self-serving statements on his wartime role.

Christopher H. Sterling

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Sperrle, Hugo (1885–1953)

Luftwaffe field marshal. Sperrle enlisted in the German army in 1903 and was commissioned the following year. He attended the War Academy in 1914, transferred to the air arm in 1915, and spent the rest of World War I in a variety of staff and command positions. He remained in the armed forces after the war, transferring in 1934 into the still-secret Luftwaffe. In 1936, he was named to head the Kondor Legion in Spain and proved successful in a job that called for great political sensitivity; his blunt professionalism in combination with a willingness to listen to his coalition partners proved popular with Francisco Franco and the other Nationalist generals.

On his return to Germany in 1937, Sperrle was double-promoted to lieutenant general and given command of Luftflotte 3 (Third Air Force), which he led for the next six years. He was promoted to field marshal after the French campaign. After the end of the Battle of Britain, Luftflotte 3 remained in France while the rest of the Luftwaffe moved east for the Russian campaign. Sperrle made Paris his occupation headquarters and succumbed to the temptations of the good life. By mid-1944, the staff of Luftflotte 3 had apparently grown as bloated and indolent as their commander; their grossly inadequate airfield preparations ruined Berlin's carefully drafted plans for a massive reinforcement of Luftflotte 3 on D-Day. When the Luftwaffe retreated to the German border with the army in September 1944, Sperrle was relieved of his command and placed in the Führer Reserve. He never returned to active duty.

Donald Caldwell

See also

German Air Force (Luftwaffe); Spanish Civil War

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Spruance, Raymond A. (1886–1969)

U.S. admiral and fleet commander during World War II. Born in Baltimore on 3 July 1886, Spruance attended the U.S. Naval Academy, graduating in 1906. His initial assignments were on surface ships, including eventual command of destroyers and a battleship. Spruance was a student and an instructor at the Naval War College, where he learned the fundamentals of operational planning. In 1938, he was promoted to rear admiral and assigned to oversee naval preparedness throughout the Caribbean. When Pearl Harbor was attacked, Spruance, commanding Cruiser Division Five, led the escorts for Admiral William Halsey's invaluable aircraft carriers.

Escorting Halsey in his early raids against the Marshall Islands and Japan itself, Spruance later took command of the task force when Halsey became severely ill. At the Battle of Midway (June 1942), Spruance again stepped in when the USS *Yorktown,* Admiral Frank Fletcher's flagship, was knocked out of action. Assuming tactical control of the entire battle, Spruance masterfully employed the air wings from the carriers *Enterprise* and *Hornet.* Four Japanese carriers went to the bottom, and Midway became the turning point in the Pacific War as Japan was forced onto the defensive and the United States assumed the initiative.

Recognizing Spruance's extraordinary combat abilities, Admiral Chester Nimitz, commanding the Pacific Fleet, brought Spruance in as his deputy. Upon promotion to vice admiral, Spruance assumed command of Fifth Fleet, responsible for offensive operations throughout the Central Pacific. His forces, fighting hard against an entrenched, determined enemy, took the Gilbert Islands (1943) and the Marshall Islands (1944), then proceeded to the Mariana Islands for an eventual showdown with Japanese airpower in the Battle of the Philippine Sea (19–20 August 1944). In what became known as the "Marianas Turkey Shoot," Spruance's planes and ships shot down more than 400 Japanese aircraft and their irreplaceable pilots, eliminating Japanese naval airpower in the war effort.

Promoted to admiral in 1944, Spruance directed the naval element in the successful amphibious assaults on Iwo Jima (February 1945) and Okinawa (March-May 1945). He temporarily replaced Nimitz in command of Pacific Fleet at the conclusion of the war. Spruance rounded out his naval career by a tour as president of the Naval War College. He retired from the Navy in 1948 but went on to serve as U.S. ambassador to the Philippines (1952–1955). Spruance died in Pebble Beach, California, on 13 December 1969.

Not a naval aviator by training, Spruance nevertheless became a carrier-minded admiral and combat leader by dint of intellect and intuition. Always shunning the spotlight, unlike some of his peers, Spruance effectively employed U.S. carrier-based airpower in several of the most decisive battles of the war.

Michael S. Casey

See also

Gilbert Islands; Iwo Jima; Marshall Islands; Midway, Battle of; Okinawa; Tarawa, Battle of

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Sputnik

The first manmade satellite to orbit in space; launched by the Soviets in 1957. During the mid-1950s, Cold War fervor and the prospect of nuclear war with the Soviet Union gripped America. By 1956, President Dwight D. Eisenhower assuaged concern over the so-called bomber gap, reassuring Americans that there was no Soviet superiority in strategic bombers and that the United States remained safe from nuclear attack. A bitter surprise took place on 4 October 1957, however, when the Soviet Union launched the first satellite into earth orbit. Named "Sputnik" (Fellow Traveller), the satellite weighed some 184 pounds and beeped as it orbited, enabling anyone with a radio to monitor its steady progress.

For Americans this was a shock. Defense pundits, especially congressional Democrats, warned that if the Soviets could launch a satellite they could launch nuclear weapons targeted at U.S. cities. Educational experts lamented that U.S. students were too busy learning about business and listening to rock and roll and not studying engineering and sciences, curricula that would enable America to maintain its lead over the Soviet Union. Americans planned backyard bomb shelters, fearful of a nuclear Pearl Harbor. U.S. rocket tests at the time were widely publicized failures, creating what Democrats then dubbed the "missile gap." Eisenhower and his closest advisers showed little concern over this perceived Soviet superiority in missiles, as top-secret U-2 overflights clearly demonstrated the real weaknesses in Soviet missile development.

Unwilling to share this knowledge with the American public, Eisenhower appeared weak on defense. The Soviets would subsequently launch a dog and, in the ultimate disgrace to American ingenuity and pride, a human, cosmonaut Yuri Gagarin, into orbit. The resulting U.S. attitude—hawkish on defense—contributed to Democrat John F. Kennedy's 1960 election as president, shortly after which new Secretary of Defense Robert S. McNamara inadvertently "revealed" that there never was a missile gap to begin with. Other than being the opening shot in the space race, Sputnik's legacy lies in the defense buildup and military policies of the Kennedy and Lyndon Johnson administrations.

Robert S. Hopkins

See also

Apollo Space Program; Cold War; Gagarin, Yuri; Mercury Space Program

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Squier, George Owen (1865–1934)

U.S. Army major general and chief signal officer (1917–1923). A native of Dryden, Michigan, Squier graduated from the U.S. Military Academy in 1887. In 1893, he received a doctorate in electrical engineering from Johns Hopkins University, perhaps the first Army officer to do so. Originally assigned to artillery duty, he transferred to the Signal Corps in 1899. As a member of that branch, Squier played a pivotal role in the development of military aviation.

In 1905, Squier became head of the Signal School at Fort Leavenworth, Kansas. There he championed the use of balloons in military operations and required that students receive formal instruction in military aeronautics. He was aware of the Wright brothers' work and followed their progress. As assistant chief signal officer, Squier helped make aviation more prominent in the Signal Corps's mission. Squier recommended the formation of an aeronautical division in 1907 and prepared specifications for the Army's first aircraft. He supervised the flight trials at Fort Myer, Virginia, and even went aloft himself.

Serving as military attaché in London when World War I began, Squier secretly visited the front and observed airplanes in action. In 1916, he took charge of the Signal Corps Aviation Section. Appointed chief signal officer in 1917, Squier assumed responsibility for the Army's aviation and communications functions. Under his direction, the Army established two important research centers: Langley Field, Virginia, and the laboratories at Fort Monmouth, New Jersey. When the aviation program fell short of the nation's high expectations, President Woodrow Wilson removed it from Signal Corps control in May 1918. Squier continued, however, to push development of airborne radiotelephone equipment. He succeeded, but too late for combat service. After retiring in 1923, Squier continued his scientific pursuits. Holder of numerous patents, he is perhaps best known as the inventor of Muzak.

Though harshly criticized for his handling of the wartime aerial program, Squier's contributions to aviation far outweigh his administrative shortcomings. He was among the first Army officers to recognize military aviation's value and helped to lay the groundwork for today's Air Force.

Rebecca Robbins Raines

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Stalingrad, Battle of (1942–1943)

Air operations during the Battle of Stalingrad are divided into two phases: before and after 19 November 1942, the date that marks the start of the Soviet counteroffensive. Until this date, General Wolfram von Richthofen's Luftflotte 4 (Fourth Air Force) dominated the skies and supported the German ground forces, although the Soviet Eighth Air Army and 102 IAD-PVO (Fighter Aviation–Air Defense) Fighter Division provided an increasingly fierce defense of the city. From October, German bombers tried to isolate the battlefield by bombing the Volga crossings and the rear areas across the river. The Soviets' sunrise counteroffensive on 19 November utilized previously hidden reserves, adding three air armies and half of Long Range Aviation's resources to the Eighth Air Army and 102 IAD-PVO, for a total of 1,400 combat aircraft in 26 air divisions. Most of these aircraft were modern types, including the newest versions of the I1-2 Shturmovik and the new La-5 and Yak-9. Soviet pilots also showed aggressiveness and a willingness to operate in bad weather.

When the German Sixth Army was surrounded, the Luftwaffe promised to supply it by air, overconfident in their successes at Cholm and Demyansk the previous winter. The Sixth Army needed a minimum of 750 tons per day, requiring 375 flights, but the Luftwaffe proved unable to deliver more than 289 tons and averaged 85. In response, the Soviets introduced several new tactics, most notably the air blockade whereby the Soviets' first priority became interdicting German transport operations. Forward-based fighter units used standing patrols and free-hunt missions, as well as ground-to-air warning systems, to intercept transports in flight while bomber and ground attack aircraft targeted the airfields at Pitomnik, Gumrak, and Tatsinskaya. Shturmoviks were also used as air-to-air interceptors against the often unescorted German transport planes. As the airfields were captured and the flight distances grew longer, supply flights became impossible, and by mid-January Stalingrad was isolated.

The Soviets claimed 1,000 German aircraft destroyed in December and January, 80 percent of them transports. The Luftwaffe admitted the loss of 488 transports and 1,000 crewmen, a loss from which it never recovered. The Soviet air forces gained new confidence and made the air blockade a standard tactic for isolating the battlefield in future operations.

George M. Mellinger

See also

Airlift Operations, U.S.; Golovanov, Aleksandr; Ilyushin Il-2 Shturmovik; Junkers Ju-52; Khryukin, Timofei T.; Richthofen, Wolfram von; Rudenko, S. I.

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Stapp, John Paul (1910–1999)

U.S. Army colonel. John Paul Stapp was born in Brazil to missionary parents. He always knew he wanted to help people, but as an adolescent his desire turned into absolute necessity after the accidental death of an infant cousin. After completing medical school at the University of Minnesota, he joined the U.S. Army and was soon transferred to the Army Air Corps.

As his interest in aviation medicine grew, he escaped the monotony of being a base doctor by developing life-support tests. Stapp served as his own test subject on many of these tests throughout the late 1940s and early 1950s.

Stapp's bravery was tested at the controls of a rocket sled in New Mexico. Stapp rode his rocket sled upward of 200 times and reached speeds beyond 600 mph, torturing his body with forces of up to 35 times the force of gravity. In one such test, after his sled stopped, Stapp undid his harness, stood, and set his own broken arm. That same test left the image of an X-1 rocket-plane permanently silhouetted in his right eye.

Stapp left an immeasurable impact on aerospace medicine. His work led to the development of better safety equipment for the pilot and better life-support systems for the aircraft. Ironically, his most significant contribution to safety on Air Force bases came on the ground, as it was Stapp's lobbying that made the wearing of seat belts in cars mandatory on all USAF bases.

Erich Streckfuss

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Stearman Aircraft Corporation

U.S. aircraft manufacturer. Lloyd C. Stearman was trained as an architect and was a naval aviator during World War I. Upon separation from the Navy, he became an airplane mechanic in Wichita, Kansas, eventually working his way up to chief engineer at the Swallow Airplane Company. He then joined with Walter Beech (founder of Beechcraft) and Clyde Cessna (owner of Cessna Aircraft). Together this trio formed their own company in 1925. Stearman left the group a year later and moved to Venice, California, to form Stearman Aircraft Company. Assisted by Mac Short, the company produced the C-1; originally powered by a 90-hp Curtiss OX-5, the aircraft carried two passengers side-by-side in the front cockpit. An improved C-2 powered by the surplus 240-hp French Salmson water-cooled radial engine evolved shortly thereafter and was followed by the C-3 with a Menasco air-cooled radial. Impressed with these designs, friends and investors invited Lloyd Stearman to bring his company to Wichita.

On 27 September 1927, the Stearman Aircraft Corporation of Wichita established a plant north of town. The new company's first product was a C-3MB mailplane for Varney Airlines. On 15 August 1929, the company became part of the colossal United Aircraft and Transport Corporation that included Boeing, Hamilton-Standard (propellers), Pratt and Whitney, Sikorsky, United Airlines, and Vought Aircraft. Lloyd Stearman became disenchanted with the large operation and departed the company in December 1930 to join Walter Varney with his airlines. In 1932, Stearman became president of Lockheed Aircraft Corporation of California.

In September 1934, the Air Mail Act forbade manufacturers of airplanes and engines from also operating airlines. Boeing withdrew from the giant United Aircraft and Transport Corporation, William E. Boeing (cofounder of the Boeing company) leaving under duress. The newly named Boeing Aircraft Company took Stearman as a wholly owned subsidiary.

In 1934, Stearman had negotiated a \$300,000 military contract for the manufacture of 61 Model 73 biplane trainers (nicknamed "Kaydets"). Eventually, a total of 8,541 Kaydet trainers were built for the U.S. Army Air Corps, U.S. Navy, and Royal Air Force. The name "Stearman" has been indelibly identified with these aircraft even though they were produced while Stearman Aircraft was part of Boeing. The Kaydet has an even greater mystique about it than its stablemate, the North American T-6 Texan. Many of these aircraft went on to serve as cropdusters and are popular performers at air shows today.

Alwyn T. Lloyd

See also

North American T-6 Texan

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STEEL TIGER (1965–1968)

U.S. code name for Laotian complement to the ROLLING THUNDER air campaign over North Vietnam. Whereas ROLLING THUNDER operated as a dual attempt at interdiction and coercive strategic bombing, STEEL TIGER was purely an interdiction campaign.

From 3 April 1965 until November 1968, STEEL TIGER was the designation given for U.S. air operations over the southeastern portions of the Laotian panhandle from Mu Gia Pass south beyond the major transshipment point at Tchepone down to the triborder area where southern Laos, northern Cambodia, and western South Vietnam converge.

During the operation, Navy aircraft flying from carriers in the Gulf of Tonkin joined Air Force planes based in South Vietnam and Thailand to strike roads, pathways, storage areas, and repair facilities along the Ho Chi Minh Trail. Although fighter-bombers dominated the skies over Laos during the daylight, they proved too fast to spot and bomb trucks effectively and too vulnerable to antiaircraft fire. For their part, the North Vietnamese abandoned most daytime operations, opting for the cover of night. Meanwhile, day and night, B-52s struck storage areas and transshipment points throughout the operation.

The most effective aircraft were multiengine fixed-wing gunships: AC-47s, AC-119s, and AC-130s. Antiaircraft fire drove the AC-47s off the most of the trail by 1966, but AC-119s and AC-130s bore the brunt of the antiinfiltration effort, known as the war on trucks. In November 1968, after ROLLING THUNDER came to an end, STEEL TIGER was extended to cover the entire Ho Chi Minh Trail area and was subsumed into Operation COMMANDO HUNT.

Earl H. Tilford Jr.

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Steinhoff, Johannes (1913–1994)

A successful Luftwaffe fighter pilot, general, and combat commander on all fronts. "Macki" Steinhoff joined the German navy in 1934 as an officer cadet and transferred to the Luftwaffe in 1935. At the beginning of the war he was a pilot in the embryonic night-fighter force but preferred daylight fighting, and in mid-1940 he was able to transfer to Jagdgeschwader 52 (JG 52; 52d Fighter Wing) as a *staffelkapitaen* (squadron leader). After a long tour on the Eastern Front, he took command of Jagdgeschwader 77 in Tunisia just as the Western Allies were wresting air superiority from the Axis. His bitter experiences in Sicily formed the basis of his first book, *Die Strasse von Messina* (The Straits of Messina). In January 1945, after commanding several fighter units, he took an active role in the so-called fighter pilots' revolt in opposition to Hermann Goering and was sent on leave. He managed to join Adolf Galland's Jet Unit of the Aces and scored six victories in the Me 262, but on 18 April 1945 his heavily loaded fighter crashed on takeoff and burst into flames. He survived with severe burns that kept him in the hospital until 1947. Steinhoff was a recipient of the Oak Leaves with Swords to the Knight's Cross of the Iron Cross; his final victory total was 178.

Steinhoff had a very distinguished postwar career. In 1955, he left his job as an advertising salesman and joined the Bundesluftwaffe, the new West German Air Force. He rose swiftly through the ranks and became *inspekteur* (commander in chief) in 1966, just in time for the most serious crisis in the force's history. Its new fighter, the Mach 2 Starfighter, was falling from the skies in alarming numbers, provoking a crisis of confidence in the West German government. Steinhoff implemented drastic changes in training and maintenance and succeeded in cutting the Starfighter's accident rate in half in four years. After being promoted to full general, Steinhoff capped off his career with a tour as chairman of the NATO Military Committee (1971–1974).

Donald Caldwell

See also

German Air Force (Luftwaffe)

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STRANGLE (1951)

UN code name for operation during the Korean War. In late May 1951, as UN forces pushed the communists back toward the 38th Parallel, the Fifth Air Force was given responsibility for aerial interdiction of seven main transport and communication highways leading to the front. Named after an Allied aerial interdiction campaign conducted in Italy in 1944, STRANGLE unfolded as a joint campaign in which northern South Korea was divided into three target areas to be attacked by Air Force fighter-bombers, Task Force 77 Navy fighters, and 1st Marine Wing aircraft. Targets were mostly vehicular roads along with bridges, tunnels, and some rail lines.

Operations began on 31 May when F-51s postholed main roads with 500-pound bombs where repairs and bypasses were most difficult to effect; B-26s then dropped inert M-83 cluster bombs, which were detonated by enemy traffic; B-29s attacked bridges. As June unfolded and enemy forces retreated, Allied air raids turned toward airfields, rail marshalling yards, and logistics supply centers. At first, Operation STRANGLE was very successful, but as UN forces slowed their offensive in mid-June, the communists could resupply and regroup front-line troops at their own pace; Operation STRANGLE thus bore diminishing results.

Much as was the case 20 years later during COMMANDO HUNT operations in Vietnam, a key to the enemy's ability to thwart STRANGLE was the enormous number of labor troops deployed to quickly repair or bypass bomb damage. Repair materials such as rocks, timber, and churned up soil were always in ready supply.

Also, as would be repeated in Vietnam, the difficulty of destroying trucks, the ease of repairing vehicles, and the vast number of new trucks supplied to the North Koreans by the Soviet Union made interdiction almost impossible. UN air forces with limited resources, due to Cold War commitments in Europe and elsewhere, could not afford to maintain the initial pace of the campaign for very long.

By July, Far Eastern Air Force (FEAF) officials reported that Operation STRANGLE was not successful. In spite of this report, the campaign continued turning to new targets such as North Korean small-arms factories and Soviet and Chinese arms supplies coming in by rail.

Rail traffic and tracks seemed an inviting target, but both proved to be difficult to destroy. Even when stretches of track or rail bridges were destroyed, the enemy would simply transfer supplies from one train on one side to another on the other side. Here again, large labor crews usually repaired the damage very quickly. Worst of all, the communists placed very effective antiaircraft artillery batteries or MiG interceptor fields around regularly attacked targets, dramatically elevating the price for destroying the target.

By the end of July, USAF planners estimated that it would take six to eight months of a concentrated air campaign to interdict enemy rail or road supply efforts. Air Force leaders believed their resources allowed for no more than 90 days.

Plans for a new operation culminated on 18 August when a six-month operation, also named STRANGLE, began. To this day, there is controversy over whether this was STRANGLE II or simply Phase II of STRANGLE I. According to FEAF officials, STRANGLE II, which lasted until 23 December, was designed to cripple the communist logistics system to the extent that rapid redeployment of their forces and supplies in support of a sustained offensive was impossible.

The second operation focused on destroying 15- to 30-mile sections of track and rail bridges. It employed group gaggles of up to 64 fighter-bombers carrying 500-and 1,000-pound bombs to drop on the 56-inch-wide tracks. These raids were supported by B-29 missions against rail bridges and airfields. Only a direct hit did any real damage, and only 25 percent of the bombs hit their targets. Considering that similar attacks in World War II had only a 12.9 percent success rate, the FEAF did well.

By November, rail lines were being destroyed faster than the enemy could repair them. The UN's victory in the air battle against North Korea's railroads seemed imminent. An increase in MiG attacks and the effectiveness of new antiaircraft batteries raised the price of the campaign to alarming levels. Most missions had to be reduced and replanned. They didn't reach initial levels again until late November. By then, massive enemy repair efforts had reversed the tide of battle. In December, Fifth Air Force reports concluded that repairmen and bridge builders had broken the railroad blockade and won back the use of the key rail arteries.

Like most Korean air campaigns, STRANGLE I and II were full of good news and bad. On a positive note, senior North Korean prisoners captured later confirmed that enemy leaders had called off a major August offensive due to the destruction of 40,000 trucks. However, never in six months did the FEAF ever effectively stop enemy resupply of its combat forces.

As was the case with aerial interdiction efforts in Vietnam, in Korea airpower hobbled the enemy without totally destroying its capacity to resist.

William Head

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Strategic Air Command

The strategic bombardment arm of the United States Air Force during the Cold War. By the end of World War II, the United States possessed the atomic bomb, a delivery system in the form of the Boeing B-29 Superfortress, radar for navigation and bombing, and electronic countermeasures for blinding enemy radar. Of even greater significance was the fact that the nation's atomic capabilities resided within a single numbered air force reporting directly to the Joint Chiefs of Staff.

A vast demobilization of U.S. military power had seen military units greatly reduced in size as servicemen became civilians once again. There were inevitably many reorganizations. One of these occurred on 21 March 1946, with the establishment of three new commands: Strategic Air Command, Air Defense Command, and Tactical Air Command. These three new commands joined the older Air Transport Command. As part of the reorganization, the Department of Defense and the United States Air Force were created on 18 September 1947 under the National Security Act.

SAC was headquartered at Bolling Field, in the District of Columbia, between 21 March and 20 October 1946, then moved to Andrews Field, Maryland, where it remained until 8 November 1948. In an effort to reduce traffic in the Washington area and to position SAC Headquarters out of harm's way, it was moved to Offutt AFB, Nebraska, where it remained for the balance of its existence.

The first commander of SAC was General George C. Kenney, who had commanded the Fifth Air Force and later Far East Air Forces in the Western Pacific under General Douglas C. MacArthur. General Kenney had served well as a theater commander with undoubtedly one of the largest areas of operations, the smallest number of assets, and at the end of a very long supply chain. While commanding SAC, General Kenney turned routine operations over to his deputy while Kenney promoted airpower to Congress, the media, and civil leaders. SAC, as with all military and naval commands during the early post–World War II era, was literally fighting for its existence, operating on shoestring budgets, and trying to maintain some semblance of military preparedness.

SAC needed to be energized and welded into a formidable force if the United States was to have any credibility during the early stages of the Cold War. Timing could not have been better for another senior officer with extensive strategic bombardment experience. Major General Curtis E. LeMay grew up with U.S. strategic airpower from its inception and commanded the nation's first nuclear force. General LeMay immediately began an extensive training program within SAC. He employed the old Army adage—"train easy, fight hard; train hard, fight easy." Missions were planned as if the United States was at war. Complex targets were selected, and the navigation legs simulated the vast distances that would be required to take the war to the enemy. From intensive individual aircrew training came more complex unit training. From this sprang a meaningful annual bombing and navigation competition that recognized the best of the best. Not only were the units recognized; outstanding crews were rewarded with spot promotions in which everyone was promoted one grade.

First and foremost, SAC was a long-range bombardment organization. These units took precedence in manning and budget. Next, SAC was a global reconnaissance organization. With inadequate intelligence, bomber crews could never effectively find and bomb their targets. Third, SAC had remembered its lessons from World War II and had its own fighter-escort units.

While trying to organize, develop, and train an effective nuclear strategic-bombing capability, SAC found itself knee-deep in the Korean War. SAC's fighter-escort units rotated to Korea for six-month tours throughout the war. Six SAC bombardment groups participated during the early stages but ran out of targets. Subsequently, only three B-29 Superfortress groups operated in the theater for the duration of the war.

Lessons from World War II led SAC leaders to believe that integral fighter-escort support would be essential for bombers to penetrate enemy air defenses en route to assigned targets. Seven SAC fighter wings made a total of 10 deployments between December 1950 and December 1954 in support of the Korean War. In January 1953, the units were redesignated Strategic Fighter Wings. SAC fighter pilots had to be proficient in air-to-air gunnery, air-to-ground gunnery, bombing, and nuclear-weapons delivery. Fighter wings were also part of SAC between 1947 and 1957.

SAC was innovative and took on challenges that would improve its warfighting capabilities. Finding the proper balance of payload versus range is the bane of mission planners—no airplane can fly its maximum load with a full fuel load. SAC found the answer in aerial refueling. Although the U.S. Army Air Corps and the British had dabbled in refueling since the 1920s, it took SAC in the late 1940s and 1950s to perfect the concept. SAC began by converting B-29s into hose and then boom tankers. Even better was the Boeing KC-97 Stratofreighter, which not only had a refueling boom but also a much greater fuel offload capability. To meet the all-jet requirements of the USAF, SAC ordered 720 KC-135s, followed by KC-10 Extenders. SAC was designated the single tanker task force manager for all U.S. military aircraft that might require aerial refueling.

Another major mission was aerial reconnaissance. When SAC was first activated, the 311th Reconnaissance Wing (Very Long Range) was assigned to the command. Although headquartered at Barksdale AFB, Louisiana, its units were distributed throughout the United States. Initially, RB-29s were the mainstay of the organization. These were strictly photoreconnaissance aircraft. Next came the Boeing RB-50s in three distinct series: The RB-50Es and RB-50Fs were employed solely for photo reconnaissance, whereas the RB-50G was equipped for electronic intelligence-gathering. Giant Convair RB-36 Peacemakers were equipped for both photographic and electronic reconnaissance missions.

The first jet reconnaissance aircraft in SAC's inventory was the North American RB-45C Tornado. This aircraft served well during the Korean War and from bases in Europe. During the Vietnam War, SAC pioneered the use of Lockheed DC-130 Hercules motherships coupled with Ryan Aeronautical AQM-34 Firebee drones. Next in the inventory came the Boeing RB-47 Stratojets, the most sophisticated being the RB-47H with a Brown Cradle belly pod housing three electronic countermeasures technicians. The Boeing B-52 Stratofortress was briefly employed in the reconnaissance role. The three most successful reconnaissance aircraft for SAC were the Boeing RC-135 Stratotankers and the Lockheed U-2 Dragon Lady and SR-71 Blackbird. SAC was restricted to peripheral reconnaissance of the Soviet Union—overflights were permitted only by direction from the president of the United States. Other overflights were strictly Central Intelligence Agency operations. Photoreconnaissance permitted detailed analysis of enemy installations and permitted development of accurate maps; electronic reconnaissance was used to gather data on enemy radar frequencies, radio frequencies, and command-and-control procedures.

In an effort to reduce the time to target, SAC began development of ICBMs. The first were powered by liquid-fueled rocket motors, making them extremely dangerous to handle. Early missiles were housed horizontally in buildings and erected to the vertical position for launch. Subsequently, ICBMs were placed in hardened underground silos for protection from any potential enemy first strike. The solid-fuel Martin Titan LGM-25 and Boeing Minuteman LGM-30 ICBMs were by far the most prolific and long-lived in SAC's inventory. Their biggest drawback was that they employed the so-called hot-shot launch method that literally destroyed the silos. It was not until the Boeing Peacekeeper LGM-118 missiles of the 1980s that U.S. ICBMs could employ a cold-shot method, thereby making the silo immediately reusable. By 1965, the number of ICBMs in SAC's arsenal exceeded that of bombers.

SAC was always innovative in its approach to its mission: deterrence. The command trained hard. It was flexible enough to recognize when changes were required. SAC adapted to the ever-changing threat and fielded new weapons systems to meet the challenges. Although some considered the manned bomber as obsolete, it is the only recallable weapons system. The time it takes to reach its target may be all that is required for policymakers and heads of state to come to a better conclusion. SAC was one of the main forces that brought the Cold War—and the Soviet Union—to an end. With these major international changes America reorganized its military forces; SAC was disestablished on 31 May 1992.

Alwyn T. Lloyd

See also

Boeing B-29 Superfortress; Boeing B-47 Stratojet; Boeing B-52 Stratofortress; Boeing KC-10 Extender; Boeing RC-135 Stratotanker; Consolidated B-36 Peacemaker; Lockheed SR-71 Blackbird; Lockheed U-2; North American B-45 Tornado; Strategic Air Command; Tactical Air Command

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Strategic Arms Limitation Treaty (SALT)

The so-called SALT talks; originated in 1969 when the Soviet Union agreed to negotiate to prevent a further weapons buildup on both sides. Initially a U.S. proposal dating back to 1964, the SALT talks had been rejected for five years because the Soviet Union perceived a lack of parity in its weapons systems (1,054 U.S. ICBMS and 656 SLBMs in 1967 compared to 460 Soviet ICBMs and 130 SLBMs). The U.S. interest, by contrast, stemmed from concern over the Soviet Galosh system, an early antiballistic missile (ABM) that first appeared in public in 1964.

Other reasons for preventing the beginning of talks revolved around definitions of strategic defense and the Nuclear Non-Proliferation Treaty (NPT) then under negotiation. With the NPT signed in 1968 and the possibility—thanks to recent satellite technology—to ensure verification without resorting to physical inspection, the Soviet Union agreed to open talks, which began in Helsinki, Finland, in March 1969 and carried on alternately there and in Vienna.

Three years later, the SALT I treaty was signed. Focusing on strategic offensive forces (ICBMS, SLBMs, and ABMs), it established four agreements, known as (1) the Accident Measures Agreement; (2) the revised Hot Line Agreement; (3) the ABM Treaty; and (4) the Interim Offensive Forces Agreement. The most important of the four was the ABM Treaty, which limited each side to two ABM sites, one around the national capital and one around one ABM site. The treaty also prohibits the testing of any sea-, air-, space-, or land-based and mobile ABM systems. Unlimited in duration, the treaty is subject to review every five years and has recently become the source of some tension between the United States and Russia, inheritor of the Soviet treaties, over U.S. plans to build Ballistic Missile Defense, the so-called Star Wars system.

SALT I did not resolve the issue of forward-based systems, which included nuclear missiles based in Europe; the

Soviet Union wanted these counted, as they could reach the Soviet homeland. The U.S. side, however, rejected this view, stating that the tactical defense of Western Europe could not be counted in the negotiation process. In addition, SALT I never dealt with a new technology, multiple independently targeted reentry vehicles (MIRVs), which allow the affixing of several warheads to a single missile, ensuring greater potency for each missile launched.

SALT II sought to deal with the MIRV problem. In the meantime, the Vladivostok interim agreement of 1974 set up the aggregate limit of launchers and bombers on both sides at 2,400, with a sublimit of 1,320 MIRVed launchers. SALT II negotiations were long and arduous. Both sides made tactical mistakes, such as issuing public offers of reduction (which, if the other side accepted, would have been interpreted as a sign of weakness). Eventually, the Soviet Union agreed to keep the numbers set under the Vladivostok agreement and to allow each side to replace an ICBM type with a new model. In the case of the United States, it was the MX, a mobile system that would have shifted the missiles from one base to another by train to reduce vulnerability. The MX plan was so expensive that it was abandoned.

The range of cruise missiles was limited, and the Soviet Union separately promised to produce only limited numbers of its new bomber, the Tu-160 Blackjack. The treaty was signed in 1979, but when Senate Majority Leader Robert Byrd (D–W.V.) was about to put the treaty to a vote in December of that year, the Soviet Union invaded Afghanistan, and the treaty was withdrawn. Although never ratified by the Senate, both sides chose to observe the provisions beyond the 1985 expiration date.

Overall, then, SALT was a positive step, helping to stave off an arms race that went beyond the minimum amount of nuclear weaponry necessary to ensure effective deterrence. However, the accords failed to account for new technologies (with the possible exception of the broad terms of the ABM Treaty) but did lay the groundwork for a new round of negotiations that culminated in the Strategic Arms Reduction Talks.

Guillaume de Syon

See also

Missiles, Intercontinental Ballistic; Missiles, Intermediate-Range Ballistic; Strategic Arms Reduction Talks

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Strategic Arms Reduction Talks (START)

When President Ronald Reagan came into office in 1981, he declared that SALT—the previous negotiations with the Soviet Union over nuclear weapons—was flawed and needed to be replaced. Thus began the Strategic Arms Reduction Talks, which called for the further reduction of ICBMs and SLBMs, taking into account the number of warheads each missile could carry (a point of contention during the SALT talks).

The START Treaty was not signed until July 1991. It called for a phased reduction of offensive nuclear forces by 30 percent. However, the subsequent dissolution of the Soviet Union made the treaty's ratification and implementation even more complicated. Eventually, the United States proposed to recognize Ukraine, Russia, Belarus, and Kazakhstan as successor states to the Soviet Union. As of November 1992, three of the four new states had ratified the treaty, and only Ukraine delayed implementation of the treaty (agreeing to its provisions in 1993). Whereas START potentially left the United States with 9,500 warheads, proposals and counterproposals made by U.S. President George Bush and Russian President Boris Yeltsin in 1992 suggested levels of warheads equivalent to those that existed in the early 1970s. Following discussions, START II called for reducing the total numbers of warheads on each side to between 3,000 and 3,500 by 2003. However, no agreement was reached to modify the 1972 Anti-Ballistic Missile Treaty. Serious political infighting followed in the U.S. Senate, which did not ratify the treaty until January 1996. However, the Russian parliament has yet to ratify START II, due to a split in opinion among the centrist Russian parties.

As of 2001, plans for START III were floundering on several issues. Calls for bringing the nuclear warheads to less than 2,000 on each side conflicted with the current U.S. strategic war plan, known as the Single Integrated Operational Plan. Based on Presidential Decision Directive 60 (November 1997), SIOP includes an enormous list of potential targets in Russia and China, a list that has actually grown rather than diminished since START II was signed. Counting backups, multiple firing scenarios, and obsolescence factors, 2,500 warheads are currently deemed "essential" in SIOP. The START III floor may be lowered somewhat due to the dismantling of land-based silos in Russia as well as older missile scrapings. However, the second Bush administration's announcement of the resumption of research and development of Ballistic Missile Defense system may further complicate the next round of negotiations.

Guillaume de Syon

See also

Strategic Arms Limitation Treaty; Strategic Defense Initiative

The different configurations of aircraft require that much inflight refueling testing be done to ensure compatibility. A Boeing KC-135 refuels a YF-22 while an F-16 flies chase. (U.S. Air Force)

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Strategic Bombing

Using bombardment from the air as a means to achieve strategic goals. Even before the invention of the airplane, there were those who speculated on how aircraft would affect war. By the dawn of the twentieth century, Jules Verne and H. G. Wells were writing of air attacks carried out against major cities and their inhabitants, with events on the ground being determined by the war in the air.

Strategic bombing first occurred during World War I when belligerents on both sides used rigid airships and heavy aircraft to deliver bombs on enemy targets far behind the front lines. Given the technology of the time, air strikes were few in number, inaccurate, and had a minor military impact. The psychological impact, however, was disproportionately large. The reaction of the public and workforce was immediate, as evidenced by factory absentee rates, the numbers of people fleeing cities for the countryside, and the clamor for government action. This strong reaction was caused by the novelty of the air weapon, not by its accuracy or destructiveness.

This belief in the psychological effects of strategic bombing strongly affected the public, governments, and military leaders during the interwar period. The three leading air theorists of this era—Giulio Douhet (Italy), Hugh Trenchard (Britain), and William "Billy" Mitchell (United States)—all assumed such a psychological impact in their projections of future war. The irony of this belief was its implicit promise that the horrors of strategic bombing would be so great that resorting to war would be less likely. In short, early air theorists saw strategic bombing as a deterrent that would keep the peace.

If deterrence failed, however, airmen hoped that strategic bombing would offer an antidote to the trench-warfare carnage of World War I. Strategic bombing, so the argument went, could bypass the tactical battle and strike directly at the "vital centers" of an enemy country. Strategic bombing, in conjunction with surface operations, would quickly bring victory. The intended targets of the bomber offensive were the industrial, economic, transportation, and government centers of the enemy. Note that it was the objective that determined whether a target was strategic or tactical, not the aircraft or weapon being used. Douhet—but not Trenchard and Mitchell—also called for direct attack on the population in the belief that their morale would break and they would demand an end to the war.

Theory outran technology. Strategic bombing in World War II was not nearly as quick or decisive as air theorists had predicted. Populations were far more resilient than expected, as were modern economies. Rather than quick victory, the war again saw prolonged and bloody attrition as the battle raged—only this time overhead as well. The devastation and dislocation caused to the economies of the belligerents by strategic bombing was enormous, but this in turn raised questions of legality and morality. Hundreds of thousands of civilians were killed in the bombing. In response, airmen noted that as awful as these deaths were, they paled in comparison to the number of civilians killed by the traditional forms of war. More than 50 million people died in World War II, and the vast majority of these were not bombed; they were shot, shelled, or starved.

Paradoxically, the advent of the nuclear era in 1945 seemed to confirm the dominance of strategic bombing in modern warfare while also rendering it irrelevant. As nuclear war became increasingly unthinkable, strategic bombing seemed to have correspondingly less utility. In the limited conflicts of the post–World War II era, airpower still played a prominent part, but strategic bombing did not. In Korea and Vietnam, strategic bombing was not seriously attempted—the political restraints were too great. Thus, during the Korean War the centers of enemy power in China and the Soviet Union were off-limits. Similarly, in Vietnam strategic bombing was put under heavy limitations, and Operation ROLLING THUNDER—the bombing of North Vietnam between 1965 and 1968—was merely a half-hearted interdiction effort.

Technology once again changed theory. The introduction of stealth aircraft, precision-guided munitions, and electronic advances had a revolutionary impact on the 1991 Gulf War. The strategic bombing of Iraq was the most accurate in history. Moreover, it resulted in an extremely low loss rate for the attacking aircraft. This performance was repeated in the air war over Serbia in 1999. Once again, strategic bombing was proven accurate while at the same time incurring low casualties (both to the attacker and the attacked). It appeared that technology had finally caught up to theory.

The problem with such a conclusion is the same that has plagued airmen for decades: How does one measure strategic effects? Destroying targets quickly and easily does not equal victory. The only useful criteria for the efficacy of strategic bombing is whether or not it achieves the established political objectives. Attempting to sort out what factors caused a belligerent to yield is not a simple process. Until such a method is found, however, the utility of strategic bombing will remain hotly debated.

Phillip S. Meilinger

See also

AWPD/1 and AWPD-42; Berlin Air Battles; Combined Bomber Offensive; Dresden Bombing of 1945; LeMay, Curtis E.; LINEBACKER II; Tokyo Air Raids

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Strategic Defense Initiative (SDI, Star Wars)

The so-called Star Wars missile defense—President Ronald Reagan's plan to build a high-tech shield over the United States to protect against ballistic missile attacks. Reagan rejected the widely accepted doctrine of mutually assured destruction (MAD). Under MAD, both the United States and the Soviet Union maintained large enough nuclear arsenals to ensure that one would be able to destroy the other even after a surprise first strike. MAD formed the basis for nuclear deterrence during the Cold War. Reagan, however, believed that he had a responsibility to defend the American people, not simply avenge them, and launched SDI in 1982.

Many advisers and foreign leaders, including British Prime Minister Margaret Thatcher, tried to dissuade him, but he continued to pursue the goal of a missile shield. To Reagan, SDI was a legitimate means of defending the American people from a deliberate or accidental nuclear attack. To SDI's domestic opponents, it was an unworkable waste of money, a dangerous attempt to destabilize the tried-and-true doctrine of MAD. To the Soviets, Reagan's pursuit of SDI was an aggressive act that could leave the Soviet Union vulnerable to a U.S. attack without the means to strike back. Although SDI was finally abandoned, the United States continued to pursue a missile defense program on a more limited scale. Under the George W. Bush administration (2001), it came to be known as Ballistic Missile Defense.

Grant Weller

See also

Missiles, Intercontinental Ballistic; Strategic Arms Limitation Treat; Strategic Arms Reduction Talks; Strategic Triad Concept

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Strategic Triad Concept

The deterrence formula used by the United States in the Cold War. The Triad consists of intercontinental ballistic missiles, submarine-launched ballistic missiles, and manned bombers, with each system offering advantages and disadvantages. ICBMs are the least expensive delivery system, can be deployed in large numbers, and are the fastest to arrive on target; but they are immobile and therefore vulnerable. SLBMs, carried aboard and launched from nuclear-powered submarines, are the most likely to survive an enemy strike but have a low availability rate due to submarine maintenance, are the most expensive weapons system to maintain, and are not capable of immediate response. Manned bombers are the most flexible deterrent system, capable of being recalled after launch, but they are vulnerable to enemy air defenses and are slow to reach their targets.

Although U.S. military leaders have made much of the Triad's three weapons systems' flexibility, it is probably not coincidental that the Triad had a role for both the Navy and the Air Force and ensured a continuing mission for aircraft pilots even during the missile age.

Grant Weller

See also

Missiles, Intercontinental Ballistic; Strategic Arms Limitation Treaty; Strategic Arms Reduction Talks; Strategic Defense Initiative

Student, Kurt (1890–1978)

The founder and principal commander of the German airborne forces. Student joined the Prussian infantry in 1910 and volunteered for air service as early as 1913. He spent World War I in various low-level air command and staff positions and remained in the service after the Armistice in the aviation testing department of the Reichswehr. In 1933, after some time in the infantry, he joined the still-secret Luftwaffe. In 1938, he began to raise the first Luftwaffe airborne division, the 7th, but it was not yet operational when war broke out. In May 1940, Student planned and led the operations of the 7th Division during the invasion of the Netherlands, during which he was accidentally shot in the head by a Waffen-SS soldier. After his recovery he planned a number of airborne attacks for the Mediterranean Theater, but the only one carried out—the invasion of Crete—was so costly that Hitler never again approved large-scale airborne assaults. Student was promoted to full general and spent a year devising plans for his gliders and paratroopers, but his men were fated to be employed as infantrymen. He was given command of the new First Airborne Army in Holland in 1944 and served briefly as commander of Army Group H at the northern end of the Western Front before being ordered into the Führer Reserve in early 1945. Plans to place him in command of a new northern army group came to naught.

Student was convicted of abetting war crimes in Crete and sentenced to five years in prison, but he was released after two. He died in West Germany in 1978 at the age of 88.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Stumpff, Hans-Juergen (1889–1968)

Prominent Luftwaffe commander. Stumpff joined the German Army in 1907 and was quickly judged to be qualified for a staff career. He attended the General Staff Course in 1917 and ended World War I on the staff of the German High Command. He remained in the service postwar, joined the still-secret Luftwaffe in 1933, and headed the Luftwaffe personnel office from 1933 to 1937.

He replaced Albert Kesselring as Chief of Staff in June 1937 and lasted 18 months; he had tired of the political squabbling in Berlin and asked for service in the field. He was promoted to full general and given command of Luftflotte 1 (First Air Force); then in April 1940 he took Luftflotte 5, the smallest of the air fleets, to Norway, where it played minor roles in the Battle of Britain and invasion of the Soviet Union. Stumpff remained in Norway until January 1944, when he returned to Germany to take command of Luftflotte Reich, a new air force with responsibility for the Reichsluftverteidigung (Air Defense of Germany)—the first time this effort had been centralized in a single command. He retained his position until V-E Day.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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SUD Aviation

Originally the French SNCASO firm; created in 1936 after the merger of several private companies. The firm made several military models after World War II, but only the Vautour II reached production. Marcel Riffard (later, Lucien Servanty) conceived the SO 6000 Triton during the war. On 11 November 1946, it became the first French jet to fly. Five of this rotund design were built. The SO 8000 Narval was a strange twin-boom naval fighter powered by an Arsenal 12H-02 piston engine. It was rejected as a poor performer.

The first interceptor designed by Servanty, the SO 6020, flew on 12 November 1948, reaching a top speed of 600 mph. Four prototypes were produced as rocket-engine test-beds for the more ambitious Trident. The SO M2 was a mockup of the 28-ton SO 4000 bomber that achieved only a single flight in March 1951. A major effort was concentrated on the SO9000 Trident lightweight interceptor. Powered by two Marboré light turbojets, one at each wingtip, and an SEPR rocket engine in the fuselage, the Trident first flew on 2 March 1953. It reached Mach 1.63 and rolled at Mach 1.4. However, stability and control needed improvement. Unfortunately, the second prototype crashed during its first takeoff attempt, and two of the three improved SO 9050 Trident IIs were destroyed during the flight-testing program. Three operational-equipped preseries airplanes flew from 1957, reaching a top speed of Mach 1.96. They established two time-to-climb world records. On 2 May 1958, a Trident II reached 24,217 meters, an unofficial world record that occurred the day the program was cancelled in favor of the conventional Dassault Mirage III.

Later, Servanty became famous again, as one of the great designers of the Concorde. In the meantime, the SNCASO firm had became Sud Aviation.

Stephane Nicolaou

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Sueter, Murray (1872–1960)

The Royal Navy's most important promoter of early aviation. As the Air Department's first commander, he firmly established the organizational and technological foundations of the naval aviation branch.

Sueter joined HMS *Britannia* in 1886. He evinced great interest in new naval technologies and, in 1896, became a torpedo specialist. Between 1902 and 1907, he served aboard the navy's first submarine depot ship and contributed to submarine development.

Sueter in 1909 became inspecting captain of airships prior to commanding the new Air Department in 1912. In July 1914, the Royal Naval Air Service separated from the Royal Flying Corps, largely at his urging. When war came a month later, Sueter oversaw the service's rapid expansion and much innovative technological development. He urged the design and rapid production of small nonrigid airships and strongly supported Commander John C. Porte's work on large flying boats. He pressed for effective torpedo-carrying aircraft that became operational during 1915. He initiated development of long-range heavy bombers that entered service in late 1916, laying the foundation for British strategic bombing.

Sueter left the Admiralty in December 1916 for an operational command in southern Italy. An intemperate campaign for greater recognition of his work on armored vehicles soon precipitated his dismissal. He remained on half-pay until 1920, when he retired as a rear admiral.

Sueter entered Parliament in 1921 and held his seat until 1945. There he pressed the development of airmail services, independent airpower, and tanks. He died in 1960.

Paul E. Fontenoy

See also

Fleet Air Arm; Porte, John C.; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Samson, Charles R.

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Suez Crisis

Exploiting the rising fervor of revolutionary nationalism, Egypt's Gamal Abdul Nasser outraged France and Great Britain by nationalizing the Suez Canal on 26 July 1956. Moreover, Nasser blockaded the Strait of Tiran, closing access to the Israeli town of Eilat, something Israel declared to be an act of war. Despite a flurry of diplomatic efforts, a military operation soon became inevitable. On 29 October, Israel, in close coordination with Britain and France, dropped paratroops into key passes in the Sinai as part of Operation KADESH. Two days later, French and British forces attacked Egypt in Operation MUSKETEER despite British avowals to the United States that no such mission was planned. The war is notable for Israel's use of blitzkrieg tactics on the ground coupled with the first all-jet aerial battles in the Middle East. Israeli Dassault Ouragons and Mystere IVs engaged Egyptian MiG-15s and de Havilland Vampires, with the Israelis quickly establishing aerial superiority. Specially modified P-51 Mustangs cut Egyptian telephone lines, reflecting Israeli creativity to use older aircraft for niche missions.

British and French aircraft, including Canberras, were largely used for strategic bombing against targets in Cairo, especially Egyptian air bases. Interestingly, a U.S. Lockheed U-2 overflight actually photographed one such British bombing raid. Global political pressure, especially from the United States and Soviet Union, constrained British, French, and Israeli advances.

U.S. President Dwight D. Eisenhower found the affair particularly frustrating, as it shifted attention away from the concurrent Soviet invasion of Hungary, giving the Soviets added freedom to act without international restraint in their client state. For Israel, the war demonstrated the crucial relationship between airpower and ground operations, particularly during the Israeli capture of Sharm al-Sheikh. The Israeli Defense Force committed to building an all-jet combat air force, relying exclusively on France as a supplier of SUD Vautours and Dassault Mirage IIIs. Both Egypt and Syria increased their dependence on Soviet aircraft and advisers. Britain and France suffered considerable international opprobrium, arguably weakening Britain to a second-rate world power.

Robert S. Hopkins

See also

Close Air Support; Dassault Mystère; English Electric Canberra; French Air Force; Israel Aircraft Industries; Royal Flying Corps/Royal Naval Air Service/Royal Air Force; Six Day War

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Sugita, Shoichi (1924–1945)

Imperial Japanese Navy (IJN) ensign. Shoichi Sugita was born in Niiagata Prefecture in 1924. At age 15, he withdrew from agricultural school to enter the IJN. In 1942, he graduated from Hei 3d Fighter Reserve Enlisted Trainee Class.

Sugita got his first victory on 1 December 1942 by shooting down a B-17 over Buin. Sugita participated in Midway but did not see air combat. As one of the flying escorts for Admiral Isoroku Yamamoto in 1943, Sugita shot down one Allied aircraft and damaged another but was unable to prevent a group of P-38s from downing the admiral's aircraft over harsh jungle terrain. This event would haunt Sugita for the rest of his life.

In December 1944, Sugita joined the 301st Squadron, an elite fighter group that was formed by Captain Minoru Genda (one of the masterminds of the Pearl Harbor attack). The group flew the newly commissioned Shiden-Kai (Allied code name "George"). On his first mission with the group, Sugita and his flight claimed three F6F Hellcats.

Sugita was killed on 15 April 1945 at Kanoya airfield when his aircraft was attacked while taking off and crashed. In a personal citation that was awarded posthumously, Sugita was credited with the destruction of 70 enemy aircraft and the joint destruction of 40 others as well as being given a double rank promotion to ensign.

David A. Pluth

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Sukhoi Aircraft

Pavel Osipovich Sukhoi was born in July 1895. He studied engineering at Moscow University and the Moscow Higher Tech School before entering the Red Army in 1920. He came to the attention of Andrei Tupolev, who became his sponsor and mentor.

Sukhoi's designs emerged in the years just before World War II. His aircraft tended toward heavily armored, rugged designs best suited for ground support missions. The Su-2 single-engine two-place fighter-bomber was typical. His Su-8, a twin-engine monoplane bomber with eight wing-mounted machine guns, was a departure from his single-engine designs but typified the direction Sukhoi designs took: rugged and utilitarian in firepower delivery. Sukhoi fighter-bombers were well-suited to Soviet army doctrine as it emerged during World War II and carried over into the Cold War: firepower and maneuverability to exploit the effects of bombing.

After World War II, Sukhoi's first venture into jet design was the Su-9. This twin-engine fighter-bomber, with its underwing engine nacelles and all-dural airframe with flush rivets, bore a striking resemblance to the Germans' Me 262.

As was the case with the piston-engine designs, Sukhoi fighters in the postwar period were heavy and better suited to bombing and strafing than to aerial combat. Among these, the single-engine Su-7 was one of the most important design series. First produced in 1958, it remained in production for 20 years and was a mainstay in the Soviet air force, as well as the air forces of the Warsaw Pact countries, and was exported to Egypt and India.

With its variable-wing geometry, the Su-22 was an advanced variation on the theme established by the Su-7 series. Although designed with dual-role capabilities for both ground support and air-to-air combat, the Su-22 was not outstanding at either. In 1987, when two U.S. Navy F-14 Tomcats made quick work of a pair of Libyan Su-22s, the mismatch in capabilities between the two was apparent.

The Su-15 Flagon interceptor was a departure for the Sukhoi design bureau. The Flagon entered production in 1967, three years after the West first learned of its existence. With its delta wing and all-missile armament, it reflected Western design themes of the era apparent in the Convair F-102 and F-106 as well as the McDonnell F-4 Phantom series. The Flagon carried two giant AA-3 Anab missiles, with one being radar-guided and the other infrared-homing.

The Su-24 was Sukhoi's most successful swing-wing design. This two-seat multirole aircraft incorporated a 23mm twin-barrel cannon in the lower centerline and could accommodate a variety of air-to-air missiles and air-to-ground armaments. Although this design closely resembled that of the General Dynamics F-111, the code-named Fencer was thought by many to be more equivalent to the F-14 Tomcat.

The Su-24 represented a transition from clunker to competitor in Sukhoi aircraft. The Su-27, which first flew in 1981, is clearly in another class. Closely resembling the McDonnell-Douglas F-15 Eagle, the Su-27 is a world-class fighter. It is currently in production in Russia and will be built in China under license.

Earl H. Tilford Jr.

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Sukhoi Su-24

NATO code name "Fencer"; a two-seat variable-geometry multipurpose aircraft. First flown in July 1965, the Su-24 entered production in 1970, and by 1981 more than 900 had been produced. The Su-24 currently exists in several variants and is what the Russians call a "battlefield bomber." With a 2.5-ton bombload, the Fencer's range of 1,115 miles allows for interdiction missions deep into the enemy rear. Reconnaissance and electronic-countermeasures models also exist.

Powered by two afterburning Tumanskii R-29B engines rated at 27,500 pounds/thrust each, the Fencer can attain a maximum speed of Mach 2.4 with no external stores and Mach 1.4 (about 1,000 mph) with a combat load of 8 tons. At first derided in the West as an "F-one elevenski," the Fencer may be a much more flexible aircraft capable of both air-to-ground and air-to-air missions, the latter never being a capability of the F-111.

The Sukhoi design bureau has offered six distinct fleet modernization programs to keep the Su-24 competitive in its several variants to 2020 and beyond.

Earl H. Tilford Jr.

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Sukhoi Su-27

NATO code name "Flanker"; single-seat all-weather air superiority fighter variants and single-/twin-seat ground attack models. It is a mainstay of the Russian air force's fighter fleet. Beginning in 1969, Pavel Sukhoi led a design team charged with building an air superiority fighter with capabilities analogous to those of the F-14 and F-15 under development in the United States. The Su-27 first flew in 1977 and entered production two years later exclusively as an air superiority fighter. Two years later, ground attack models were observed.

A versatile aircraft, the Su-27, in addition to its internal GSh-301 30mm cannon with 150 rounds, can carry a wide range of ordnance on six underwing pylons and three fuselage stations. In 1993, a specially prepared Su-27 set 31 official world records, including a streak to 39,370 feet in 55.42 seconds.

China has received more than 50 Su-27s in recent years and has a license to build 200 at the Shenyang Aircraft Factory. Many of the former Soviet republics include Su-27s in their inventories, and models have been exported to Vietnam, Syria, and Ethiopia.

Earl H. Tilford Jr.

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Supermarine Aircraft

British manufacturer of classic warplanes. In 1913, the flamboyant British pioneer aviator Noel Pemberton Billing, obsessed with the idea of flying over the sea, created the firm that became Supermarine Aviation to design and manufacture flying boats. Supermarine joined the Vickers Group in 1928 and ceased independent operation in 1958.

The company's products fell into four basic categories. The first contained single-engine general-purpose flying boats and amphibians for both military and civilian use that began with the Baby in 1918 and terminated with the Seagull ASR.1 in 1948. Large multiengine flying boats, beginning with the Swan in 1924 and ending in 1934 with the Stranraer, formed the second group. There was also the highly specialized series of racing monoplane seaplanes built to compete for the Schneider Trophy between 1925 and 1931. Finally, between 1936 and 1958 the company produced a succession of single-seat landplane fighters from the Spitfire to the Scimitar.

The single-engine flying boats originated in Supermarine's cooperation with the Admiralty's Air Department during World War I. They mated conventional biplane flying surfaces with Linton Hope's innovative monocoque wooden hulls that combined light weight with great strength and flexibility. The firm developed the basic design, offering flying boats and amphibians ranging from the single-seat Sea Lion Schneider Trophy racers to the multiplace reconnaissance Seagulls and Scarabs. In the 1930s, Supermarine further developed this series into the metal-hulled Walrus and Sea Otter amphibians that saw widespread service in the reconnaissance and air-sea rescue roles.

The larger flying boats evolved from the earlier types. The first boats used wooden hulls, but the Southampton II introduced a lighter, stronger, all-metal design. Progressive refinements culminated in the Stranraer, some of which served as airliners into the 1960s.

The Schneider Trophy racers mated the smallest possible airframes with the most powerful available engines. The S.4 of 1925 was an all-wood cantilever-wing monocoque airframe using a special 700-hp Napier Lion engine. The S.5 adopted a duralumin monocoque fuselage and wing-surface radiators with the engine boosted to 750 horsepower, in which form it won the 1927 race. A new 1900-hp Rolls-Royce R engine powered the all-metal S.6, which won in 1929. In 1931, the S.6B, using an R engine developing 2,300 horsepower, won the Schneider Trophy in perpetuity for Great Britain.

Reginald Mitchell's Spitfire was among the most important and successful aircraft ever developed, but subsequent Supermarine single-seat fighters were far less successful. The Attacker and Swift were overshadowed by their rivals, Hawker's Sea Hawk and Hunter, and the Scimitar's performance failed to match either its elegance or its engines' sheer power. Vickers closed Supermarine's design office and terminated its independent existence in 1958 with the firm's fortunes at a low ebb.

Paul E. Fontenoy

See also
Mitchell, Reginald J.; Supermarine Spitfire

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Supermarine Spitfire

Probably the most successful British fighter of World War II; placed in front-line service throughout the war. At least 22,759 Spitfire and Spitfire variants (photoreconnaissance aircraft and naval fighters) were built between March 1936 and March 1949 in 54 major marks (not counting variants in engine fit and prototypes).

The Spitfire was a pilot's airplane—a very responsive aircraft with superb control harmony that gave the pilot plenty of feedback as maneuver limits were approached. The ability of the Spitfire's airframe to accept progressively more powerful engines was a major factor in its continued success. Its only real fault was a relative lack of range on internal fuel (approximately 490 miles for a Mk.1, 660 miles for a Mk.VIII/IX with fuselage tank).

The Spitfire Mk.I was fitted with a Rolls-Royce Merlin III producing 990 bph using 87-octane fuel. It was armed with eight 0.303-inch Browning machine guns and played an important part in the Battle of Britain. A number of performance improvements were made during 1940, including the use of 100-octane fuel. From November 1940, all Spitfires were retrofitted with metal ailerons that increased the roll rate at high speed. The Mk.II was fitted with a 1,140-bhp Merlin XII. Tactical comparisons with a captured Messerschmitt Bf 109E showed that the Spitfire had a much better turning circle, was generally more maneuverable (particularly at high speed), and that the Bf 109 had a slightly better climb below 20,000 feet and was able to accelerate faster in a dive.

Photoreconnaissance Spitfires were stripped of nonessential equipment and received a highly polished paint finish. They carried two F.24 cameras and were 10–15 mph faster than standard Spitfires. Subsequent versions carried much more fuel, increasing range to a respectable 2,000 miles.

The Mk.V entered service in February 1941 and had a 1,450-bhp Merlin 45. It served in every theater during World War II and fought with distinction during the defense of Malta. Most Mk.Vs were armed with two 20mm Hispano cannons and four 0.303-inch Browning machine guns. The Mk.V was comparable to the Messerschmitt Bf 109F2, but it was severely disadvantaged by the Focke-Wulf Fw 190A, which outclassed the Spitfire V in every department except turning circle. The Spitfire LF Vb with a 1,580-bhp Merlin 50M redressed the performance balance at low altitude at the expense of performance above 12,000 feet, and a much higher rate of roll was achieved by removing the detachable wing tips.

Seafire Mk.Is, IIs, and IIIs were basically Spitfire V airframes with more powerful Merlins, local strengthening, arrestor hooks, and catapult spools on the later marks. The Seafire LIIc was equipped with a 1,640-bhp Merlin 32 and a four-bladed Rotol propeller and had an outstanding low-level performance (similar to the Spitfire LF Vb). Seafires required skill and precision to land on a carrier deck; their accident rate was high.

The Mk.IX appeared in June 1942 as an interim solution to the Fw 190 threat but eventually became the most numerous subvariant. It had a 1,565-bhp Merlin 61 with a two-stage supercharger that provided improved overall performance and large amounts of excess power at around 30,000 feet. Tactical comparisons of the Mk.IX with captured enemy aircraft showed that the Mk.IX was superior to the Messerschmitt Bf 109G6 in climb, turning circle, and roll and was mostly faster, although the Bf 109 was its equal around 16,000–20,000 feet and accelerated better in a dive. The Spitfire was also slightly faster than the Fw 190A, climbed better, and had a tighter turn although the Fw 190A had a much better roll rate and dive acceleration. The Mk.VII and Mk.VIII were similar to the Mk.IX but had a strengthened airframe and some detail aerodynamic improvements. The Spitfire XVI was the designation given to a Mk.IX with a Packard-built Merlin 66. Spitfire PR XIs were initially converted from Mk.IX airframes and carried two vertical cameras.

The Mk.XIV entered service in January 1944 and was equipped with 2,035-bhp Griffon 61. This engine gave a much better performance than the Mk.VIII and Mk.IX at all altitudes and a startling initial climb rate of more than 5,100 feet per minute, but the flight characteristics suffered slightly because of the huge amount of power that had to be absorbed by the relatively light airframe.

During 1944, Spitfires were fitted with Gyro gun sights, type E wings with two 20mm Hispano cannons and two 0.5-inch Brownings, a larger-area rudder, a bubble canopy, and additional fuel tanks in the rear fuselage.

The Spitfire Mk.XXI entered service in January 1945, and had a completely revised stronger wing with larger ailerons, and an armament of four 20 mm cannons. The Mk.XXII and Mk.XIV were externally identical to late-model Mk.XIs. The Seafire 47 was the last Spitfire version and had a contrarotating propeller to eliminate torque effects.

Andy Blackburn

See also

Aircraft Armament; Britain, Battle of; Focke Wulf Fw 190; Gun Sights; Malta, Siege of; Messerschmitt Bf 109; Mitchell, Reginald J.

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Suprun, Stepan (1907–1941)

Soviet test pilot and fighter ace. Stepan Pavlovich Suprun was born on 2 August 1907 in Ukraine but emigrated to Canada. In 1924, he returned to the Soviet Union and later trained as a pilot. He became a favorite of Stalin and received wide publicity. In 1939, he flew as a volunteer in China, scoring eight air victories. In June 1941, he formed a regiment of test pilots to fight at the front. Suprun scored another four victories before being shot down on 4 July 1941. He was twice awarded the Hero of the Soviet Union (20 May 1940 and posthumously on 22 July 1941).

George M. Mellinger

See also

Soviet Volunteer Pilots

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Sutyagin, Nikolai (1923–1986)

Korean War Soviet fighter ace. Captain Nikolai Vasilevich Sutyagin was born on 5 May 1923 in Smagino, Russia. He entered the air force in 1941 and spent World War II in the

Far East, seeing brief combat against the Japanese in August 1945. From August 1951 to February 1952, he flew 150 missions over Korea with the 17 IAP (Fighter Air Regiment) and was credited with 22 individual and two group air victories, making him the top-scoring Korean War ace on either side. He was awarded the Hero of the Soviet Union on 10 October 1951. During the late 1960s, he was the chief air adviser to the North Vietnamese air force. In 1978, he retired with the rank of major general; he died on 12 November 1986.

George M. Mellinger

See also

Fighter Air Corps; Pepelyaev, Evgenii Georgievich

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Swedish Air Force

In 1926, Swedish army and navy air units were combined to form an independent air force. But Swedish strategy was dominated by the navy and its fleet of coastal warships, including three new armored cruisers. Consequently, the air force was not considered equal to the other armed forces; its organization was rudimentary and its funding was neglected. The Defense Act of 1936 put the air force on an equal footing with the army and navy, expanded air force structure to include a staff, operations division, and college, and substantially increased funding.

In the course of the 1930s, 48 British Hawker Hart single-engine biplane light bombers, 42 of them license-built, were secured. In 1937, 55 Gloster Gladiator biplane fighters were ordered from England. Saab was founded to assemble and build 53 Junkers 86K twin-engine medium bombers. To replace the Hart, Sweden selected the U.S. Northrop 8A-1 single-engine attack monoplane, 102 of which were license-built in Sweden.

In 1938–1939, 46 U.S. engineers worked in Sweden. The Swedes learned the American way of working in teams. The impact of U.S. design and production techniques proved decisive for future Swedish aircraft production.

In 1939 and 1940, Sweden desperately needed modern fighters to replace the Gladiator. Sixty Seversky P-35s were delivered in June 1940. The Swedes secured 72 obsolete Fiat biplanes and 60 Reggiane 2000 monoplanes from Italy.

To keep up with the rapid pace of wartime technology, Sweden was compelled to greatly expand its warplane industry. Obstacles were many: shortages of engineers, machine tools, and duraluminium. Engines were the worst bottleneck. The radial Bristol Mercury of 980 horsepower was license-built. The Swedes copied and built the radial 1,065-hp Pratt and Whitney Twin Wasp. Protracted difficulties with the inline 1,475-hp Daimler-Benz delayed production until the end of the war.

Saab produced the first all-metal stressed-skin aircraft of Swedish design, a single-engine light bomber, 322 of which were built. In service, it was rugged, reliable, and possessed substantial payload and range. Since Saab needed all available duraluminum, the J-22 fighter was constructed of steel tubing and plywood. Some 500 companies outside of the aircraft industry were harnessed to produce 198 J-22s, which began to enter service in 1943. The compact fighter featured excellent handling and climb, but its speed was limited by the Twin Wasp engine.

Developed during the war but not in service until 1945, the Daimler-Benz–powered Saab 21A featured a rear-mounted engine with pusher propeller, a twin-boom tail unit, and tricycle landing gear. Fast, well-armed, and an excellent ground attack machine, 302 of these unconventional warplanes were manufactured.

The Swedish air force did successfully defend Swedish airspace in World War II. Many straying or damaged aircraft were escorted to Swedish airfields, including 126 German, 63 British, and 141 U.S. machines.

The Parliamentary Defense Act of 1948 emphasized airpower and jet fighters. Initially equipped with English de Havilland Vampires and, later, Hawker Hunters, the Swedish air force entered the jet age. Saab developed a series of outstanding jet fighters. Engines from Britain and the United States were license-built with power much enhanced by afterburners, a Swedish specialty. Weapons were secured from Britain and the United States and some were manufactured in Sweden. A sophisticated electronics industry emerged to meet military needs.

The J-29, aptly nicknamed the "Flying Barrel," entered service in 1951. A swept-wing design, the rotund fighter set a world speed record in 1954, averaging 607 mph over a 310-mile course. In 1963, J-29Fs were armed with U.S. Sidewinder air-to-air missiles. Saab factories were expanded to produce 661 of the de Havilland Ghost-powered Flying Barrels.

To meet the need for attack and night-interception missions, Saab designed the two-seat, large, swept-wing, Rolls-Royce Avon–engined J-32 Lansen (Lance). A search-and-attack radar was incorporated into the machine. The sleek Lansen could cover any section of the long Swedish coast in any weather, day or night, armed with a Swedish radar-homing antishipping missile. The night-fighter J-32B was well-armed with four 30mm British cannons and four U.S. Sidewinders. Between 1955 and 1960, 449 J-32s were manufactured.

By the mid-1950s, the Swedish air force numbered 1,000 jet fighters in 50 squadrons, all of them modern and most of Swedish design. From the 1960s, the Swedish air force has emphasized dispersed operations in wartime. Initially, such operations employed hardened sections of roads. These operations have been expanded to include networks of runways well concealed in the forests. Mobile support units service and repair the warplanes. Commando teams protect aircraft and crews. Consequently, Draken, Viggen, and Gripen fighters possess STOL capabilities. Designed to maintain a high and sustained sortie rate, these fighters can be refueled, rearmed, and serviced under wartime conditions by a ground crew of six.

By 2004, the Swedish air force will be reduced to eight fighter squadrons. But cutting-edge technology continues to be emphasized. Close cooperation with other nations is now a hallmark of Swedish policy. Sweden participates in the NATO Partnership for Peace program of exercises.

A compact and lightweight machine, the new Saab JAS-39 Gripen (Griffin) is a multipurpose fighter able to shift quickly from one role to another.

The history of the Swedish air force illustrates what effective leadership, close partnership between the armed forces, government, and industry, and a high level of education can achieve.

Sherwood S. Cordier

See also

Gloster Gladiator; Saab J-35 Draken; Saab J-37 Viggen; Saab JAS-39 Gripen

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Swiss Air Force

Although the Swiss army had decided as of 1911 that it might need aviation for observation purposes, no further action was taken in light of budgetary constraints. By 1914, however, under a 1912 fund drive, the Swiss air force came into being, but it was completely unprepared for World War I, as it was unable to take delivery of six German LVG machines it had ordered before the war started. Instead, Cavalry Captain Theodor Real, who commanded the Aviation Troops (later Flugwaffe, or Flight Weapon), was forced to rely on eight civilian machines and its mobilized owners. In addition, two balloon companies were assigned to border observation to maintain Swiss neutrality. By 1916, Real was encouraging a local aircraft industry.

By war's end, the Swiss air force included 112 pilots flying a mix of captured aircraft along with indigenous machines. However, it had seen little use, for it lacked a clearly defined legal status, and many in the army did not believe in the value of military aviation. The moment the war ended, pilot numbers fell to 30, with 234 machines spread among five squadrons.

Things began to change in 1925, when the federal government formally recognized the existence of an air force. Over the following 15 years, air force officers (lobbying through their association, AVIA), convinced the Swiss parliament to approve a budget to buy the necessary aircraft to renew the fleet. By 1933, 40 Fokker CVs and 65 Dewoitine D-27s were in service. The air force's strategy, however, remained focused on reconnaissance, thereby hindering the use of the new weapon as a guardian of Swiss neutrality. Thus, when Germany began sending troops and aircraft to Spain to fight in the civil war, no interceptions of the machines over Swiss airspace ever took place. No plans were made, however, to supply Switzerland with fighters until 1938, when the government acquired a license to manufacture Morane-Saulnier 406 aircraft. In addition, Messerschmitt Bf 109Ds and -Es were ordered.

In World War II, the Swiss air force used its meager resources to guard national airspace, intercepting and shooting down several German aircraft. However, Switzerland's awkward position of economic dependency on Nazi Germany led some Swiss officials to condemn these actions and to end air patrols against any incursions of fewer than three aircraft. Confrontations with Allied aircraft also occurred, leading to the interception and capture of lost bombers (more than 100 B-17s and B-24s).

After World War II, the Swiss air force entered the jet age by first acquiring British-built de Havilland Venom and Vampire jets. Failure to successfully develop an indigenous fighter led the government in the 1950s to order Hawker Hunters, which served as front-line interception machines, then as ground-attack types until retirement in 1994. Meanwhile, the Swiss air force entered the supersonic age with the Dassault Mirage III, first evaluated in 1961 but not delivered until 1970 due to a serious appropriations scandal that shook the air force leadership. The Mirage was completely retired at the end of 1999 and replaced by Northrop F-5s, in service since 1978, and some 34 Lockheed Martin F-18s ordered in the 1990s.

Unlike the other branches of the army, the air force is not a formal army corps and functions autonomously. In peacetime, the Flugwaffe's aircraft are flown by a combination of militia personnel (the principle is similar to that of the U.S. National Guard) who serve a total of six weeks per year. There are also professional pilots who man the surveillance and interception squadron, but for legal reasons they are considered to be government employees whose desks happen to be cockpits.

Guillaume de Syon

See also

Pilatus; Swiss Aircraft Industry

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Swiss Aircraft Industry

The Swiss aircraft industry, like most Western European counterparts, experienced a golden infancy prior to and during World War I before facing economic and technical challenges associated with a small country's industrial potential.

Prior to World War I, pioneers Armand Dufaux and René Grandjean each sold aircraft they had designed to the army. During World War I, several engineers designed and produced local machines for use by the newly established air force. Robert Wild and August Häfeli each worked on new models, but regardless of progress in their respective designs the limited availability of suitable engines prevented a successful expansion of their businesses.

After the war, Häfeli continued to design aircraft at the Federal Construction Works in Thun, and the government-owned Swiss Locomotive Works in Winterthur began developing an aircraft engine. However, the Saurer firm offered a better engine by simply licensing a 150-hp model from Hispano-Suiza. This allowed the Swiss air force to order far more machines of the same series than ever before (in this case, the Häfeli DH-3 M IIIa) and gave a boost to aircraft manufacturing. As for private aircraft construction, it was dormant in 1918 as a result of the Swiss Locomotive and Machine Works (Schlieren) failing to successfully compete for a contract offered by the Swiss authorities for a training machine.

From then until 1925, all Swiss aircraft production was done under direct government supervision. In early 1926, however, the owner of an aircraft repair shop, Alfred Comte, set up his own company and sought to compete for military and civilian contracts. His AC-1 aircraft lost to the Dewoitine D-27, but the prototype was nonetheless acquired and served to train pilots in high-altitude flying until the late 1930s. Comte went on to design other projects, the most successful of which was the AC-4 Gentleman, a two-seat trainer that sold well enough to keep the company afloat.

The Great Depression, however, eventually forced Comte into bankruptcy, and several of its engineers transferred to the Pilatus factory, established in 1939. One exception was the Dornier factory in Altenrhein, on the Swiss bank of Lake Constance. Established in 1926, it manufactured the giant Dornier DO-X and dabbled in hydroplane projects throughout the interwar years. During World War II, the company was involved in studying various projects, such as a fighter based on the Morane-Saulnier 540. It later became known as FFA, focusing instead on training and light aircraft. Overall, then, limited orders and a lack of a clear appropriation process kept the Swiss aircraft industry limited to a few models. By the 1930s, it was clear that it was easier to purchase aircraft abroad than to begin new projects form scratch under limited funding.

One could, however, build under license. For example, the Federal Aircraft Factory in Emmen was involved manufacturing of Morane-Saulnier 406s under license.

After the war, with the advent of the jet age, the Swiss air force considered proposals for a combat jet from Swiss manufacturers. FFA's proposal was rejected in favor of the Federal Aircraft Factory's new delta combat aircraft proposal for four years, the N-20 Aiguilles. Engineers had relied on two 3:5-scale models, one flying as a glider, the other (the Arbalester, or Crossbow) with a small engine, to determine the best aerodynamics. Advanced though it was, the N-20 lacked power, as taxi trials showed that the four turbofan engines in the wings gave insufficient thrust. Following parliamentary refusal to allocate further funding for better engines, the project was abruptly cancelled in 1953, prompting many engineers to resign in disgust. The N-20 was a remarkable machine, and some of the knowledge acquired through its design helped in the preparation for another indigenous project, the P.16.

Although begun at approximately the same time as the N-20, the P.16 only flew two years after the Federal Aircraft Factory project shut down. Specifically tailored to Swiss climactic and geographic conditions, it was intended as a ground attack fighter. However, the first prototype crashed in the summer of 1955, after a fuel line failed (the pilot ejected safely). The second prototype, completed in 1956, was evaluated the following year and given moderate to good marks, and an order for 100 P.16 Mk.IIs was placed in 1958. The first preseries aircraft, however, also crashed during tests, and the project was suddenly dropped, even though FFA built two more planes at its own costs to no avail. The knowledge acquired was not entirely lost, however. At the time, the Swiss American Aircraft Corporation (SAAC) was formed with offices in Wilmington, Delaware, and Saint Gallen, Switzerland. Its founder, Bill Lear, capitalized on the P.16 wing and other features and used it on the SAAC 23, which became the first Learjet.

As a result of the N-20 and P.16 failures, the Swiss aircraft industry moved away from the full manufacture and design of front-line aircraft in favor of specialized machines (Pilatus and FFA offering trainers and light transports), as well as licensed production of planes the Swiss air force purchased (such as the F-5 in the 1970s and 1980s). Such assembly practices included preassembly of parts at the aircraft factories Federal Aircraft Factory in Emmen, FFA in Altenrhein, and Pilatus in Stans. In addition, other companies offered aircraft maintenance and spare storage, as in the case of the Farner firm. Engine manufacture has also taken place under license, for example, with production of the Mirage SNECMA ATAR 9C3 power plant by Sulzer in Winterthur. Thanks to licensing, technical know-how is maintained, and the Swiss economy benefits through the creation and maintenance of jobs at lower costs compared to full programs.

As is the case with the Israeli aircraft industry, the Swiss sought to improve equipment bought off-the-shelf, as with the Mirage III. Aside from costly modifications to match the support infrastructure, the plane benefited from improvements to the Hughes weapons-control system for the HM-55S Falcon AAM and later from the installment of canard winglets, developed independently from those found on the Israeli Kfir.

Today, the Swiss industry is involved in many aerospace projects for major manufacturers. Major Swiss consortiums as well as smaller companies work as subcontractors on projects such as radar electronics, helicopter composite parts, and rocket cones. As for the dreams of a major indigenous aircraft for defense purposes, they have been replaced with the reality of smaller civilian and trainer projects.

Guillaume de Syon

See also

Pilatus; Swiss Air Force

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Syrian Air Force

Despite a history of many defeats, the Syrian air force remains one of the most potent in the Middle East. The air force was founded following the withdrawal of French forces in 1946. In the early 1950s, British-supplied fighters became the country's first combat aircraft. Strong ties with Egypt led to a transition to Soviet aircraft around 1955. The Israelis destroyed the majority of Syria's MiG-15s on the runways during 1956.

The largest buildup for the Syrian air force occurred following the election of Hafiz al-Assad (1930–2000) in March 1971. Shortly after being elected, President Assad, himself a pilot, began to build up the armed forces and foster strong ties with the Soviet Union that laid the foundation for the modern air force. The MiG-21 and MiG-23 air superiority fighters quickly became the backbone of the force, with some 400 eventually being delivered. In addition, Syria was one of a handful of countries to receive the MiG-25 high-speed interceptor. Its primary mission is to act as a force multiplier by engaging either AWACS or other high-value air assets. The fixed-wing ground attack role is filled primarily by Su-22s, Su-24s, and MiG-27s (the ground attack version of the MiG-23). The rotary ground attack role is filled by air force–operated Mi-25 and Gazelle attack helicopters.

The latest round of upgrades began in 1987 with the delivery of the advanced MiG-29 fighter. The upgrades came just in time, as very few of the MiG-21s and MiG-23s remained fully operational. Acquisition of the MiG-29 provides Syria an aircraft capable of battling Israeli F-16s for air supremacy.

Troy D. Hammon

See also

Mikoyan-Gurevich MIG-21; Mikoyan-Gurevich MIG-29; Six Day War; Sukhoi Su-24; Yom Kippur War

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Systems Management

The set of managerial methods originally developed in the U.S. Air Force during the 1950s to develop large-scale weapons systems such as ICBMs. In 1965, these techniques became the standard for the Department of Defense. The essential elements of systems management are project organization, systems analysis, systems engineering, configuration management, and phased planning.

Project organization stems primarily from ideas gleaned from the Manhattan Project and implemented first through "project officers," assigned to each weapons system, who would coordinate the activities of contractors and government personnel. Systems analysis was developed by the RAND Corporation in the late 1940s and early 1950s as an implementation of mathematical techniques of operations research to proposed technologies and operations.

Systems engineering stemmed from government-industry interactions between the Massachusetts Institute of Technology, Bell Telephone Laboratories, and the Army during this same period and was instituted in the Air Force through the hiring of the Ramo-Wooldridge Corporation and, later, the creation of the Aerospace Corporation in 1960.

Configuration management was originally developed by Boeing in the late 1950s for aircraft manufacturing and came to the Air Force through Boeing's involvement as the integrating contractor on the Minuteman ICBM project. Phased planning was instituted by the Department of Defense in 1961 and 1962 during Robert McNamara's tenure as secretary of defense.

All of these ideas came together between 1954 and 1962 for ICBM development and, later, in Air Force Systems Command, led by General Bernard Schriever. While managing the ICBM program, Schriever circumvented the Air Force's usual processes and created new ones more suited to large, complex systems. These resulted in the AFR 375 series of regulations for systems management published between 1959 and 1961.

Stephen B. Johnson

See also

Missiles, Intercontinental Ballistic; Schriever, Bernard A. "Bennie"

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T

TACAMO

An airborne communications system for use with submarines. The development of the fleet ballistic missile submarine brought a new challenge—how to communicate while submerged. The preferred answer was a land-based extremely-low-frequency system known as Sanguine. But this system required a long development effort, so the Navy began an interim project to place very-low-frequency (VLF) transmitters on aircraft. The unusual TACAMO acronym ("take charge and move out") was reportedly a challenge to the development team to get the interim system fielded as quickly as possible. With the passage of time, however, the acronym became synonymous with the mission itself.

The original TACAMO system was installed on a Lockheed C-130 during 1962 using a 25-kilowatt VLF transmitter radiating through a single 30,000-foot trailing wire antenna. As Sanguine became involved in increasingly heated debates over environmental and political issues, improved versions of TACAMO were fielded. By 1971, the TACAMO IV configuration used a 200-kilowatt transmitter and dual trailing wire antennas. Altogether, Rockwell Collins delivered 22 EC-130G and EC-130Q aircraft.

By the late 1970s, it was obvious that Sanguine would never be completed, but the EC-130s were becoming old and seriously overloaded with equipment. The Navy selected the E-3A AWACS airframe. This modified version of the venerable Boeing 707-320 was shielded against electromagnetic interference and had high-capacity electrical generating systems but opted for more powerful CFM56 engines. In April 1983, the Navy ordered 15 E-6As but, in order to save money, opted to transfer the communications equipment from the EC-130s as they were retired.

The age of the Air Force's Airborne Command Post EC-135s led to the incorporation of national command authority battlestaff positions and a specialized airborne launch-control system (ALCS) into the E-6B. The ALCS is capable of launching U.S. land-based ICBMs, in addition to the traditional TACAMO role of launching submarine-based missiles. The first E-6B was accepted in December 1997 and assumed its dual operational mission in October 1998. The E-6 fleet was scheduled to be completely modified to the E-6B configuration by 2003.

Dennis R. Jenkins

See also

National Emergency Airborne Command Post (NEACP)

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Tactical Air Command (TAC)

Established on 21 March 1946 as a major air command; disestablished in the early 1990s. TAC was responsible for all tactical air assets in the post–World War II era. On 1 December 1948, TAC was reduced from major command status and assigned to Continental Air Command as an operational command. During this period, TAC was principally involved in air reserve training programs and field exercises. TAC became an operational and administrative command under Continental Air Command on 20 September and returned to major air command status on 1 December 1950.

TAC's primary mission was to support Army ground forces, perform battlefield reconnaissance, and interdict railways and roads used to support the enemy's front-line forces. Equally important, TAC provided tactical airlift, primarily through troop-carrier operations. TAC developed the C-130 and numerous other tactical airlift aircraft and systems and was the first home of Air Force Special Operations aircraft and systems.

Initially, the principal aircraft were propeller-driven Republic F-47 Thunderbolts and North American F-51 Mustangs. Regarding jet-propelled fighters, the Lockheed P-80 Shooting Star entered operational service with TAC during the spring of 1946 on a limited basis. The Republic F-84 Thunderjet followed in December 1947. Both jets were considered as training aircraft for the fledgling pilots learning to cope with the different performance of jet aircraft.

When the Korean War erupted in June 1950, Far East Air Command fought a holding action using its heavy bomber and fighter units. TAC units were then deployed to the theater on a rotating basis throughout the conflict along with fighter units from the Air National Guard and Strategic Air Command. TAC also began rotating its units to bases in Europe primarily for training, as well as to augment existing forces stationed at Allied bases.

After the Korean War, two major international crises allowed TAC to flex its muscles and show U.S. resolve to protect peace around the world. First came the Taiwan Strait Crisis in 1955 when TAC deployed fighters and fighter-bombers to Taiwan. In 1958, TAC deployed a composite strike force to Lebanon. The show of force in both instances resulted in peaceable political solutions. The Nineteenth Air Force, better known as the "Suitcase NAF," lead the way in developing tactics, techniques, and procedures for deploying air forces during the Cold War.

The Cuban Missile Crisis occurred during the second half of 1960. Many of TAC's tactical units were deployed to bases in the southeastern United States in case they were needed. Both Strategic Air Command and TAC reconnaissance units performed admirably in gathering compelling data on the installation of Soviet ballistic missiles in Cuba. It was this data, coupled with U.S. political resolve, that convinced the Soviets to take their missiles home before an invasion of the island was necessary.

Larger aircraft used for tactical air support initially were the Douglas A-26 Invader, used effectively during World War II. The A-26 was also employed in Korea and again in special operations during the Vietnam War. Jet-powered light bombers came into the TAC inventory during the 1950s (the North American B-45 Tornado and Douglas B-66 Destroyer). Although the former was short-lived, the latter was converted into a jamming aircraft that flew support for tactical operations during Vietnam. Another tactical bomber employed by TAC was the British-designed Martin B-57 Intruder, which also served in Southeast Asia. For nighttime close air support, TAC developed and deployed three different gunships to Southeast Asia: the Douglas AC-47, Fairchild AC-119, and Lockheed AC-130.

TAC's principal airlift organization during the 1950s was the Troop Carrier Command. This mission was performed by TAC until the mission was transferred to Military Airlift Command in the 1970s.

The mid-1960s resulted in a reduction and final elimination of TAC's bomber force, which was replaced by an all-fighter force of larger, more capable aircraft such as the Republic F-105 Thunderchief and McDonnell F-4 Phantom II. Both of these aircraft performed a variety of missions during Vietnam, including the new Wild Weasel surface-to-air missile suppression role.

TAC pursued development of the LANTIRN system (Low Altitude Navigation and Targeting Infrared for Night) for installation on the F-15E and F-16C/D to significantly increase the combat effectiveness of these aircraft by allowing them to fly at low altitudes, at night, and under the weather to attack ground targets with a variety of precision-guided and unguided weapons. In April 1986, initial operational test and evaluation of the LANTIRN targeting pod proved that this precision-attack mission was indeed feasible. The Air Force approved low-rate initial production in June 1986. Introduction of the LANTIRN revolutionized night warfare by denying enemy forces the sanctuary of darkness and was combat-proven during Operation DESERT STORM.

TAC developed a number of electronic-warfare systems. In Southeast Asia, EB-66s provided navigation and electronic-countermeasures support for fighter organizations. With the Boeing E-3 Sentry in 1976 came an electronics package that permits the aircraft to serve as an airborne battle management command post. These aircraft also served in the secondary role of drug interdiction. Tethered Aerostat balloons were added to TAC's inventory in the 1980s. These balloons are permitted to rise to altitudes where their radar can see over the horizon and detect drug-trafficking operations.

When Air Defense Command was inactivated in 1979, the air defense mission was transferred to TAC but was mainly performed by the Air National Guard.

During the Gulf War, TAC assets were flown to the Middle East. The first unit to deploy was the 1st Fighter Wing from Langley AFB, Virginia. Not knowing what they would find, TAC sent the aircraft fully armed. Strategic Air Command aircraft provided tanker support from Barksdale AFB, Louisiana.

TAC's Tactical Air Warfare Center at Eglin AFB, Florida, was responsible for testing new weapons systems and developing tactical air warfare doctrine. TAC developed a large tactical air warfare training center at Nellis AFB, Nevada, known as the Red Flag Range. There students were taught aerial tactics and flew missions to hone their skills. At the Red Flag Range, TAC pilots and aircrews underwent rigorous classroom lectures and then put their lessons to the test, flying simulated combat missions over the range. A vast tracking system is part of the range and records all aircraft operations, which can then be debriefed in the classroom to show the students their effectiveness. The Red Flag Range was home for the Tactical Fighter Weapons Center, which was developed as a result of America's poor showing during the early years of the Vietnam War. During the 1980s, the range was opened to other USAF organizations flying bombers, tankers, and transports. The range still exists under the auspices of Air Combat Command.

Lessons learned in Southeast Asia resulted in the bare-base concept in which civil engineers are deployed to airfields that are useable by the tactical aircraft; prefabricated structures are brought in to serve all building requirements to conduct composite air strike operations.

Lessons learned since Vietnam permitted TAC to redefine its doctrine and tactics to meet the ever-changing threat. With the major reorganization of the Air Force in 1992, TAC, MAC, and SAC were disestablished. On 1 June 1992, Air Combat Command was established and gained all of the tactical fighter and support resources of TAC, the bombers, reconnaissance assets, and ICBMs from SAC, and parts of what had been MAC.

Alwyn T. Lloyd

See also

Air Defense Command; Air National Guard; Cuban Missile Crisis; DESERT STORM; Far East Air Forces; Korean War;

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Tactical Air Warfare

The use of airpower in combat operations within a theater of war. Tactical, or theater, air operations normally focus on the defeat of deployed enemy military forces in pursuit of national strategic objectives.

Historically, tactical air missions have primarily supported surface forces in joint multiple-service campaigns to defeat enemy surface forces and the supporting air arm. In comparison, strategic air operations are designed to directly accomplish national objectives, normally by attacking the enemy homeland. However, some theorists and the example of post–Cold War air operations (e.g., Operation DESERT STORM and Operation ALLIED FORCE) highlighted the potential of independent air operations and suggested redefining the concepts of tactical and strategic actions.

The core tactical air missions all emerged during World War I, with refinements during the interwar period and World War II. The primary combat missions in theater air warfare are reconnaissance, air superiority, close air support (CAS), and interdiction. Additionally, airpower provides important contributions to theater operations through a range of other roles, including airlift, aerial refueling, defense suppression, combat search and rescue, psychological operations, electronic warfare, airborne warning, and command and control.

At the beginning of World War I, the primary role for aircraft was reconnaissance/observation. Aircraft were used to extend the eyes of the ground commander and enhance his understanding of the situation facing his forces. The reconnaissance mission evolved during World War I to include photographs that could be more closely analyzed by specialists on the ground and provided more details than could be collected through visual observation.

During the interwar period and World War II, the art of reconnaissance developed rapidly, especially involving photographic missions. The Cold War saw continued development of reconnaissance techniques with improved sensors—including infrared, television, and radar—and platforms, especially satellites, combined with enhanced communications systems to allow the rapid use of the information by commanders and attack planners.

The value of reconnaissance led the air forces to develop aircraft designed to attack enemy reconnaissance aircraft, denying the use of the air to the enemy. These specialized aircraft—fighters—also protected friendly operations from enemy attack, ensuring access for all types of air operations. The fighter aircraft mission was to control the air, thereby gaining air superiority over the battlefield and, if possible, over the theater. Fighter operations could be defensive or offensive in nature. Defensive operations initially involved patrols of designated areas, a tactic that continued throughout the twentieth century. However, the effectiveness of defensive sorties was higher when the fighters were directed by a control system that warned of enemy air attacks and guided the defenders to the area of the threat. Aircraft specifically designed for the defensive reaction mission became known as interceptors, and their operations were complementary to ground-based antiaircraft systems.

During World War I and the interwar years, the warning and control systems for air defense operations relied on visual observation and listening posts to identify the location of threats. By World War II, the control of defensive fighters was enhanced by radar and radio control networks. After

World War II, computer-based control systems and new detection capabilities, such as airborne radar and control platforms, significantly improved the effectiveness of air defenses. Although defensive counter-air capabilities are required to combat enemy air attacks, offensive counter-air operations are considered the most effective means of gaining control of the air, or at least limiting the ability of the enemy to effectively use his airpower.

Fighters conduct several types of offensive counter-air missions, including sweeps over enemy territory, escort of friendly air missions, and attacks on enemy airfields and supporting facilities. During the Cold War, nuclear weapons provided a strong probability of success for planned airfield attacks. Late in the Cold War and during the post–Cold War period, precision-guided weapons allowed highly effective conventional attacks on airfields.

Although aircraft were used to attack ground targets in limited situations before World War I, the fighter pilots during that war began to use their machine guns to attack ground forces when opportunities developed. Fighter pilots and crews on observation aircraft also began to drop bombs on enemy targets. These informal ground attacks grew into formal missions, and aircraft were specifically designed for the role and generally identified as attack, fighter-bomber, or bomber aircraft. Operations involving direct support for ground forces in contact with the enemy became know as close air support. These missions were coordinated with artillery attacks and provided a flexible and responsive form of fire support for ground forces. During World War I, commanders also recognized the additional value of the extended range of aircraft and directed attack and bomber aircraft to strike enemy units and resources that were located far enough to the rear to be out of range of conventional artillery. These deep attacks became known as interdiction missions, designed to destroy, delay, and disrupt the movement of enemy forces and supplies before they could be committed to combat.

After World War I, ground attack capabilities grew significantly, especially in those nations that were developing mechanized ground forces. The speed, range, and flexibility of airpower made it a logical complement to fast-moving ground forces. In addition to specialized attack aircraft, operational concepts, doctrine, organizations, and command-and-control networks were necessary for the effective use of airpower in tactical operations. The German and Soviet militaries were very aggressive in the development of air-ground operational concepts. Other military forces involved in light military operations, such as the U.S. Marine Corps, also developed concepts for close coordination between attack aviation and ground forces. During World War II, the value of air-ground collaboration was validated in virtually all theaters, especially in the initial German Luftwaffe operations and then the successes of Soviet Frontal Aviation and British and U.S. tactical air forces. After air superiority was achieved, CAS and interdiction air attacks were a major factor in most successful theater campaigns.

Although ground forces personnel in all militaries tended to view CAS as the most important attack mission, senior theater commanders and air commanders tended to emphasize deeper missions as more effective in supporting theater-level plans (and strategic air advocates pushed for emphasis on so-called decisive targets). The inherent flexibility of airpower allowed commanders to shift aircraft from deep missions to CAS when the tactical situation required, as in defensive emergencies or during rapid offensive actions. After World War II, operational concepts, organizations, and command-and-control systems tended to build on the model of that war. During the Cold War period, ground-attack capabilities steadily improved with technological advances that enhanced communications and control systems, provided accurate and timely intelligence, reconnaissance, and targeting information, and allowed precision target identification and attack. In the post–Cold War period, the potential of deep attack based on quick target identification, survivable stealth aircraft, precision attack capabilities, and standoff precision weapons reinforced the orientation of air leaders and senior joint commanders toward the concept of independent, potentially decisive air operations.

In situations in which decisive operations were not possible or were not the focus of planning due to political or other factors, tactical airpower remained a critical component of theater operations. As in the early period of military aviation, the first priority remained securing the operating environment by achieving air superiority and then supporting the theater commander by providing clear information as well as focused firepower in CAS, interdiction, and strategic attack missions.

Jerome V. Martin

See also

Air Interdiction; Air Superiority; AirLand Battle; Close Air Support; Frontal Aviation; Tactical Air Command; U.S. Air Force Doctrine; World War I Aviation

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Tank, Kurt (1898–1983)

German aircraft designer. Kurt Waldemar Tank was born in Bromberg-Schwedenhohe, Germany, on 24 February 1898. He served in his father's cavalry regiment during World War I as a lieutenant and company commander, earning several medals and being wounded several times. His requests for transfer to the flying corps were denied because of his excellent soldiering. His idle time during the war was spent with a physics book, concentrating on fluid dynamics. After the war, he obtained an electrical engineering degree in Berlin in February 1924 with optional courses in mechanics, flight mechanics, and aerodynamics. Later, he was awarded an honorary doctorate and professorship. In his spare time while a student, he worked on sailplane construction and flying.

Upon graduation, his first job was with Rohrbach, where he expanded the design department. He made significant contributions to the design of all Rohrbach aircraft from then until he left. Tank at this time initiated his habit of test-flying his designs. In January 1930, Tank left Rohrbach to become director of the project department at the BFW firm in Augsburg, working for Willy Messerschmitt. Tank's philosophy of robust structural design was in conflict with Messerschmitt's ultralight design approach, and Tank left BFW in September 1931. He became director of the design and flight-test departments at Focke-Wulf two months later. Even as department manager, Tank continued to exercise significant influence on conceptual design. The Focke-Wulf Fw 190 is the most famous result of his work, the design of which was requested directly from Focke Wulf by the Technische Amt (Technical Office) in 1938 as a backup for the Bf 109 because of its high accident rate upon introduction into service. Another famous Tank design was the Fw 200 Condor airliner, conceived in March 1936 as a challenge to apply current technology to develop a transatlantic airliner, which was proven in several record-setting flights in 1938. Almost all of the designs he influenced were noteworthy, and this made his services in demand after Germany lost the war.

In 1947, Tank and about 60 colleagues from Focke-Wolf emigrated to Argentina to continue development of the Ta 183 jet fighter into the swept-wing FMA Pulqui II, which first flew June 1950, after which Tank did much flight-testing himself. In February 1956, Tank accepted design responsibility for the Indian HAL Marut fighter, first flown June 1961, and continued with HAL until the early 1980s. He then returned to Germany for a consultancy with the MBB firm. He suddenly took ill and died on 5 June 1983 in Munich.

Douglas G. Culy

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Kurt Tank's influence on German aircraft design is obvious. The Fw 190 is the most famous result of his work, the design of which was requested to replace the Bf 109 because of its high accident rate. (Smithsonian Institution)

Taran (Ramming)

An unusual method of combat developed in World War II by Russian aviators involving deliberate aerial collision. Ideally, the attacking pilot either hit the enemy aircraft in a vital spot with his wing tip or used his propeller to chew up the enemy's tail surfaces. Although the tactic was frequently fatal for the attacker, with skill and luck a pilot could expect to survive, bailing out of his damaged aircraft or even returning to land at his airfield. The pilot's chances for survival distinguish this desperate tactic from the Japanese kamikaze attacks as well as Pyotr Nesterov's World War I suicide-ramming. During the early days of the war, pilots executed tarans when their old fighters ran out of ammunition. As the war progressed it became less common, but it was used until the end of the war in special circumstances. There may have been as many as 430 taran victories, N. D. Gulaev and B. I. Kovzan claiming four each and Aleksei Khlobystov actually conducting two successful tarans during one flight while flying a P-40. The taran does not seem to have been used in Korea, but on 28 November 1973 Captain G. N. Eliseev rammed an intruder over the Transcaucasus, winning a posthumous Hero of the Soviet Union.

George M. Mellinger

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Taranto Air Attack (1940)

The first carrier-based aircraft strike against a fleet of warships. Located on Italy's eastern coast, Taranto was the main Italian naval base in early World War II. The excellent natural

The sensational victory at Taranto was closely studied by the Japanese, who applied the methods at Pearl Harbor. (U.S. Navy) harbor comprised two anchorages—Mare Grande and Mare Piccolo. When Italy entered the war on 10 June 1940, its sizeable Mediterranean fleet became a threat to the British, who were fighting alone following the fall of France that May.

The Axis envisioned this fleet controlling the Mediterranean shipping lanes and reducing supplies to British forces in North Africa. Concurrently, the Royal Navy sought to engage and destroy the Italian fleet to limit the resupply of Erwin Rommel and the Afrika Korps. To this end, Admiral Andrew B. Cunningham, commander in chief Mediterranean, sent British ships near the Italian coast to lure (without success) the Italians into a surface engagement.

British intelligence reported that increasing numbers of large ships were congregating at Taranto. Thus, Cunningham ordered his operational commander to plan an airborne carrier attack for 21 October 1940—Trafalgar Day.

Originally, the HMS *Eagle* and the new HMS *Illustrious* were to launch the attack. However, a fire aboard *Illustrious* delayed the operation until 11 November—Armistice Day. Additionally, *Eagle* suffered bomb damage and was removed from the operation. Some of its aircraft were transferred to *Illustrious.*

At 8:40 P.M. 11 November, *Illustrious* launched 12 old and slow Swordfish biplanes of the Nos. 813 and 815 Squadrons 170 miles southeast of Taranto. Fourteen Fulmer and four Sea Gladiator fighters of No. 806 Squadron flew air cover. Two Swordfish carried flares and four carried bombs. This first group arrived over the target at 11:00 P.M. and illuminated the harbor with the flares; the aircraft armed with bombs made a diversionary attack on the cruisers and destroyers.

The last six Swordfish in the first wave, armed with one torpedo each, attacked the six Italian battleships anchored at Mare Grande. A single torpedo put a hole in the *Conte di Cavour,* which began to sink. A second torpedo tore a hole in the *Caio Duilio,* which was run aground in shallow water. The first wave lost one plane; the crew survived.

Less than an hour later, as Italian crews were fighting fires and searching for shipmates, a second wave of nine Swordfish from Nos. 819 and 824 Squadrons struck. Five of the planes had torpedoes. This time the *Littorio* was heavily damaged and also run aground. A second torpedo hit the *Cavour,* sending it to the bottom in deep water. Numerous lesser ships were also damaged. The second wave lost one plane; both crew members were killed.

In one night, the British had taken a major step in wresting control of the Mediterranean from the Axis. The remainder of the Italian fleet soon withdrew to Naples on the western coast and out of range of British carrier planes. The *Cavour* took enormous resources to refloat and never returned to service. The other two were refloated in two months, but it took many more months to make them seaworthy. By that time the Italian navy was less of a factor. Cunningham noted that after Taranto the Italian fleet "was still a considerable force" but had been badly hurt.

Although some historians remain unconvinced, there is evidence that Britain's Taranto air attack inspired Japanese Admiral Isoroku Yamamoto to launch the 1941 carrier-based air attack on Pearl Harbor. Regardless, at Taranto a single British carrier and 21 antiquated biplanes crippled the Italian fleet in one nighttime raid, proving the vulnerability of surface vessels to aerial assault.

William Head

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Tarawa, Battle of (1943)

Part of Operation GALVANIC, the Allied assault on the Gilbert Islands during World War II. This was the opening round of the U.S. Navy's offensive in the Central Pacific and the baptism of fire for the Pacific Fleet's new Fast Carrier Task Force.

The GALVANIC air plan drew on three principal sources: General Willis H. Hale's VII Army Air Force (90 B-24s), Rear Admiral Charles A. Pownall's Task Force 50 (11 carriers with 702 aircraft), and eight escort carriers (embarking 228 aircraft) in two air support groups. Sixty-six land-based Navy patrol-bombers supplemented the Army B-24s, and some 100 Marine Corps aircraft provided base defense in the Ellice Islands.

Japanese air defenses against U.S. forces were far fewer. All but one of the Combined Fleet's carriers were in home waters, and their air groups were ashore at Rabaul. In early November, the imperial navy had also transferred most of its land-based aircraft from the Gilberts to reinforce Rabaul, leaving only 46 aircraft in the entire area when the assault began.

Preliminary U.S. offensive operations involved individual fast carrier task groups that raided Marcus Island, Tarawa and Makin, and Wake Island between 1 September and 6 October 1943. Although these raids inflicted significant damage, their real value lay in the operational training they provided to the new air groups. Furthermore, raiders brought back invaluable low-level photographic coverage of Tarawa's beaches, which was supplemented by Army and Navy land-based photoreconnaissance during October.

As D-Day approached, land-based air intensified its attacks on both Makin and Tarawa as well as airfields within supporting range. On 19 November, Task Force 50 aircraft provided ground support as Army troops landed on Makin. The following day, as the Marines went in at Tarawa, a major dawn air attack by Army and Navy forces formed part of the bombardment plan. Subsequently, Task Force 50 attack aircraft supplemented those of the escort carriers in providing dedicated ground support throughout the operation.

The first significant Japanese aerial counterattack occurred late on 20 November. Land-based torpedo-bombers seriously damaged the carrier USS *Independence,* which had to return to Pearl Harbor for major repairs. During GALVANIC, Task Force 50 fighters ensured that not one Japanese air attack disrupted unloading, and none of the several counterstrikes against the fleet caused further damage. During the operation on 25 November, Rear Admiral Arthur W. Radford's group also conducted the first carrier nighttime interceptions, defeating a torpedo attack during which Lieutenant Commander Edward O'Hare was shot down.

Paul E. Fontenoy

See also
O'Hare, Edward H.; Rabaul

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Task Force 38/58

The fast carriers of the U.S. Pacific Fleet during World War II. The Fast Carrier Task Force, initially designated Task Force 50, became Task Force 58 (TF58) on 6 January 1944. Thereafter it would be designated either TF58 or TF38, depending on whether Admiral Raymond F. Spruance or Admiral William F. Halsey was commanding the Fifth or Third Fleets, the matching designations of the Pacific Fleet. Throughout TF58's existence, Vice-Admiral Marc A. Mitscher commanded it; Vice Admiral John S. McCain alternated as commander of TF38 from October 1944.

TF58's first operation was the invasion of the Marshall Islands between 29 January and 11 February 1944. Its strikes won complete air control over the operational area. Only one significant Japanese air attack developed, and not one U.S. naval vessel was attacked.

Between 17 February and 1 April, a series of Pacific raids followed. Targets at Truk, Saipan and Tinian, and the Palau Islands were struck. The carriers' aircraft sank combatant vessels and merchant shipping and destroyed aircraft and shore facilities. They then supported landings at Hollandia, New Guinea, and struck Truk again as they withdrew.

TF58 next sailed in support of landings in the Marianas. The carriers launched heavy assaults on Saipan, Tinian, Guam, Iwo Jima, and Chichi Jima during 11–15 June, then provided cover for landings on Saipan itself. The Japanese Combined Fleet sortied to break up the U.S. attack. In the ensuing Battle of the Philippine Sea (19–20 June), TF58 fighters destroyed three-quarters of the Combined Fleet's entire strength on the first day with little loss. The long-range pursuit the next day, however, cost TF58 dearly. Its aircraft sank a carrier, and submarines two others, but 80 planes were lost on the return from the strike due to fuel shortage and the onset of darkness.

In October, TF38 played a key role in the Battle of Leyte Gulf, during which Japan lost four carriers, three battleships, nine cruisers, and other smaller vessels; American losses were one carrier, two escort carriers, and three smaller craft. The Leyte campaign also witnessed the introduction of Japanese suicide air attacks—the kamikazes.

TF58 next conducted a series of raids on Formosa and Japan to cover landings on Iwo Jima in February 1945. After further raids on Japan, the fast carriers struck Okinawa in preparation for landings that began on 1 April. They continued to support the operation through late May, pulling away only to crush a Japanese surface fleet sortie to attack the invasion force. TF58's aircraft sent *Yamato* to the bottom on 7 April amid a hail of torpedoes and bombs. No fast carriers were lost during this entire period of intense operations, but kamikazes heavily damaged three off Kyushu and a further three off Okinawa.

McCain's force next raided targets in the China Sea and then, from 10 July, commenced an almost continuous period of operations against the Japanese home islands that ended only with the formal surrender of Japan on 2 September 1945.

Paul E. Fontenoy

See also
British Pacific Fleet; Guam, Battles of; Iwo Jima; Japan, Air Operations Against; Kamikaze Attacks; Leyte Gulf, Battle of; Marshall Islands; Okinawa; Palau, Battle of; Philippines; Tokyo Air Raids

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Task Force 77

Formed in late June 1950, initially as an Anglo-American force built around carriers HMS *Triumph* and USS *Valley Forge. Triumph* departed on 31 July to join an all-British force as additional U.S. carriers arrived.

Offensive operations against North Korea commenced 3 July, but soon Task Force 77 (TF77) began providing essential close air support for the U.S. Eighth Army's retreat. After the situation stabilized, TF77 recommenced attacks on North Korean targets, preparing for landings at Inchon. The carriers provided defensive cover and close air support for this successful amphibious stroke and the advance northward.

When Chinese forces crossed the Yalu River, TF77's airpower again was crucial. It covered the second UN retreat, helped stabilize the front, provided close support through two long years of stalemate, and conducted offensive operations against North Korea in pursuit of the eventual ceasefire.

In 1964, as tension rose in Vietnam, TF77 was on station. On 2 August, when North Vietnamese torpedo boats attacked *Maddox,* carrier aircraft reacted. The retaliatory strikes against torpedo-boat bases that followed immediately marked the start of U.S. naval aviation's longest and most costly war.

ROLLING THUNDER, the full-scale strategic offensive against North Vietnam, began on 2 March 1965 and continued until 31 March 1968 with intermissions intended to induce North Vietnam to begin peace talks. TF77 contributed its striking power to this air campaign, taking responsibility for eastern areas. When ROLLING THUNDER ended, there were few indications that the campaign significantly impacted North Vietnam's will to fight, although naval air contributed greatly to halting the 1968 Tet Offensive.

In November 1968, President Lyndon Johnson ordered a halt in offensive operations over North Vietnam, which President Richard Nixon continued. TF77 operations interdicted Ho Chi Minh Trail traffic and supported ground forces in South Vietnam as needed.

The United States broke off stalemated peace talks on 23 March 1972; North Vietnam launched its expected offensive a week later. TF77 aircraft first supported South Vietnamese defenders and then struck northern targets. Operation LINEBACKER (10 May–22 October) intensified this campaign and incorporated a crippling mining campaign against harbors and waterways.

A halt did not hasten peace—North Vietnam hardened its position and broke off negotiations. During LINEBACKER II TF77 contributed 505 sorties in 11 days of intense operations that brought negotiators back to the table. Peace was signed on 23 January 1973. Nevertheless, operations continued over Laos and Cambodia until Congress ordered their complete cessation by 15 August.

Paul E. Fontenoy

See also

Close Air Support; Ho Chi Minh Trail; Indochina; Korean War; LINEBACKER II; ROLLING THUNDER; Vietnam War

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Taylor, Maxwell Davenport (1901–1987)

U.S. Army general. As Army Chief of Staff in the late 1950s, Taylor criticized the doctrine of massive nuclear retaliation. After retiring, he published *The Uncertain Trumpet* (1959), which argued for a new defense policy—flexible response. Taylor did not accept Giulio Douhet's theory that airpower alone could win or prevent wars. This was the theory upon which massive retaliation was based. Taylor offered the Korean War as an example of a limited war that nuclear superiority could not prevent or atomic bombs win. As the Soviet Union acquired nuclear weapons and ICBMs to deliver them, Taylor believed that mutual deterrence between the United States and Soviet Union had been achieved. Therefore, the Soviets could wage only limited wars using conventional means. Taylor thus argued for an increase in conventional forces with which to counter the Soviets in limited wars. At the same time, he supported the production of faster bombers and higher-yield nuclear weapons to deter the Soviets. His views found favor with President John F. Kennedy, who brought him out of retirement to serve as chairman of the Joint Chiefs of Staff.

John L. Bell

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Tedder, Arthur W. (1890–1967)

Royal Air Force marshal. A diverse, spectacular career as a pilot, staff officer, operational commander, strategist, and diplomat marks Arthur W. Tedder as one of Britain's most influential airmen.

Born in 1890, Tedder entered the Royal Flying Corps after an injury prevented World War I service in the infantry. He flew in combat and commanded a squadron over the Somme before commanding a training wing in Egypt. After World War I, Tedder excelled in a variety of command and staff positions focused on training, including tours on the directing staff, RAF Staff College (1929–1931) and director of training, Air Ministry (1934–1936). He served as director-general of research and development (1938–1940) before earning fame as deputy, then air officer commanding in chief, RAF, and Middle East (1941–1943).

Partnered with Air Marshal Arthur Coningham, Tedder developed and executed forward air support links, the basis for a viable air-ground communications system. Equally important, Tedder worked effectively with Eighth Army commanders, including Claude J. E. Auchinleck and Bernard L. Montgomery, to gain air superiority and then form combined air, land, and sea campaign plans. As air commander in chief, Mediterranean Command (1943), and deputy supreme Allied commander (1943–1945), Tedder worked skillfully with General Dwight D. Eisenhower and played a major role in creating Allied strategy in Europe. He became known for the so-called Transportation Plan to isolate and immobilize German forces during the Normandy invasion and subsequent drive across France.

After World War II, Tedder succeeded Charles Portal as chief of the air staff (1946–1950). He shaped U.S.-U.K. early Cold War strategy as chairman of the British Joint Services Mission to Washington and as the U.K. representative to NATO's Military Committee (1950–1951). Capping his distinguished career, Tedder's books *Air Power in Modern War* and *With Prejudice,* as well as his Lee Knowles lectures at Cambridge, are classics of airpower theory. He died in 1967.

John Farquhar

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Tereshkova, Valentina (1937–)

Textile worker and weekend parachutist who became the first woman in space. Valentina Tereshkova was the first woman to fly in space on 16 June 1963 aboard Vostok 6. She remained in orbit 70 hours, 50 minutes in order to eclipse the U.S. Mercury program's combined astronaut flight time of 54 hours. She was launched two days after Valeri Bykovsky, aboard Vostok 5, to make up the second Group Flight of the Vostok program to study the medical effects of spaceflight on more than one human body in space at the same time. She was married to fellow cosmonaut Andriyan Nikolayev and divorced him as soon as Nikita Khrushchev fell from power in 1964. Released from the Cosmonaut Corps in 1969, she served as a member of the Central Committee of the Communist Party and the Congress of Peoples' Deputies. She lives in Moscow.

John F. Graham

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Terror Bombing

A bombardment concept that derives from strategic-bombing experiences begun in World War I and repeated during the Spanish civil war, World War II, and Vietnam. With strategic bombing defined as the destruction of a country's warmaking potential (as separate from its armed forces), the notion of terror-bombing becomes part of coercive airpower, demoralizing the individual element and thereby reducing national will to make war.

In his book *The Command of the Air* (1921), the Italian theorist Giulio Douhet began formalizing the notion of strategic bombing that would hit deep inside enemy territory. In the United States, proponents of strategic bombing and its terror dimension followed in the footsteps of General William "Billy" Mitchell and began to voice their opinions during the interwar years at Maxwell Field's Air Corps Tactical School, stressing the need to destroy vital centers on which modern life depended, thereby disrupting the social fabric of society.

In practice, however, the differentiation of targets within the strategic realm became difficult. Nighttime bombings of London during the Blitz and after (when no precision bombing was possible) killed almost 30,000 civilians yet failed to destroy the industrial potential as well as the morale of the population. When the types of targets were close together, or when the bombing of civilian targets was deemed an acceptable alternative to an industrial installation, attacks were carried out in massive waves. These yielded only limited results despite heavy loss of life.

Studies carried out at the end of World War II showed that even though support for one's leadership may have declined under terror-bombing, it did not imply a spiraling downward of the social system. Rather, civilians clung to elements of everyday life that indicated normality and turned their energy toward survival. Yet psychological investigation of air attacks suggested that a highly devastating initial attack, combined with repeated attacks increasing with time and targeting troops, may bring about some measure of success as a climate of fear builds in enemy areas. Consequently, despite arguable results, the notion of terror-bombing as part of coercive airpower has continued since World War II and was used during the Vietnam War and Gulf War.

Guillaume de Syon

See also

Dresden Bombing of 1945; Harris, Arthur T.

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Terrorism

Throughout history, used as an instrument of political, military, and religious policy. It has been used by citizens in rebellion against an oppressive regime, by guerrilla troops against an invading enemy, and by the enemy against guerrilla troops. It was not until the latter part of the twentieth century that terrorism began to use airpower, primarily via the hijacking of civilian aircraft.

Initially, the objectives of hijacking were limited: gaining passage to another country or obtaining hostages, who were then used to negotiate ransoms or the release of prisoners. Then the acts of terror escalated as terrorists began to plant bombs aboard airliners, using the murder of innocent passengers as the instrument of their message.

The first hijacking of a U.S. aircraft occurred on 1 May 1961, when an airliner was forced to fly to Havana, Cuba. Over the years more aircraft were hijacked, one of the most spectacular being the 27 June 1976 seizure of an Air France airliner by the Baader-Meinhof Gang and Popular Front. The aircraft, with 258 passengers, was forced to land in Uganda. The passengers were rescued by Israeli commandos on 3 July in the famous Entebbe Raid. Terrorists also used bombs to bring down aircraft, including an Air India aircraft on 23 June 1985 and Pan Am Flight 103 on 21 December 1988. The latter aircraft was blown up over Lockerbie, Scotland; all 259 people aboard perished.

In addition to the successful Entebbe Raid, airpower has been used against terrorists, the most notable being Operation EL DORADO CANYON, which took place on 14–15 August 1986. U.S. Air Force and Navy planes struck targets in Libya. As a result, Libyan terrorist operations were substantially reduced for an extended period of time.

The 11 September 2001 hijacking of four U.S. airliners, three of which were then used to attack the World Trade Center and the Pentagon (the fourth crash-landed following the passengers' attempt to regain control, killing all aboard), was the beginning of a new and terrible chapter in world terror. The responsibility for the criminal acts rested with Osama bin Laden and the al-Qaeda terrorist group, although many other similar groups of Islamic orientation were implicated in the attacks.

Because of the shadowy nature of the terrorist organizations, as well as their use of Afghanistan and the Taliban government as a home base, airpower became the decisive weapon to counter terrorism. Rooting out the terrorist network, which was virtually inaccessible otherwise, was made possible only through the application of the most modern elements of airpower, including precision-guided munitions.

The air war in Afghanistan was conducted with skill and effectiveness, especially considering the difficulties of geography and terrain in Afghanistan, as well as U.S. determination to cause as few collateral casualties as possible. The war against terrorism in Afghanistan was also a signal that war would be conducted in a similar way against other terrorists and the states that support them.

The world is now more alert to the possibility of terrorists using airborne means to inflict damage upon innocent people to further their self-proclaimed jihad against the West, particularly the United States. These means might include the use of crop-dusting aircraft to dispense chemical or biological agents, as well as the use of private aircraft to crash into government or civilian facilities, including nuclear power plants. Traditional methods, such as hijacking or placing bombs on board airliners (including suicide bombers), remain a serious threat.

Although many Muslim leaders deny that Islam as a religion permits terrorist acts, others argue that it is in fact an Islamic duty to join the terrorists in their fight. Therefore, future battles in the fight against terrorists could take place on a worldwide basis, with attacks in Western states being met by counterattacks against states that sponsor terrorism all around the world. The official war on terrorism may have begun on 11 September 2001; it is impossible to say when it will end.

Walter J. Boyne

Thomsen, Hermann von der Lieth (1867–1942)

Key figure in creating the Luftstreitkräfte (German Air Service during World War I). Hermann von der Lieth-Thomsen was born in Flensburg, on the German-Danish border, in 1867. He served on the German General Staff (1901–1903, 1905–1914). Thomsen was awarded the Pour le Mérite on 8 April 1917 for his efforts in creating the German Air Service.

Assigned to oversee developments in military aviation in 1908, Thomsen championed airpower throughout World War I. In April 1915, he was named chief of field aviation. Displeased with the lack of strategic planning for aviation, he worked toward unification of all of the diverse agencies responsible for training, aircraft procurement, and deployment of flight troops into an independent branch of the service. In October 1916, the Luftstreitkräfte was established—as part of the Army—under the command of General Ernst von Hoeppner, with Thomsen as Chief of Staff.

After the Armistice, Thomsen served briefly and helped organize military air-courier lines between Weimar and other cities. He retired from the Army on 11 August with the rank of *oberst* (colonel), then spent five years in Moscow negotiating secret contracts between Germany and Russia. Blindness ended his career in 1928, and he died at his home on the island of Sylt in 1942.

Suzanne Hayes Fischer

Tibbets, Paul W. (1915–)

U.S. Air force brigadier general; piloted the B-29 that dropped the first atomic bomb on Japan. Born in Quincy, Illinois, Paul Warfield Tibbets moved to Florida in 1924. There he experienced his first plane flight with Douglas Davis (later a celebrated Eastern Airlines pilot) aboard a Waco 9. After pursuing a premed program in college, Tibbets applied to become a flying cadet in the Army Air Corps in December 1936.

Tibbets entered flying training Randolph Field, Texas, where he flew Consolidated PT-3 and North American BT-9 aircraft. In February 1938, Tibbets earned his wings at Kelly Field and was commissioned a second lieutenant at Fort Benning, Georgia. There he met and married his wife, Lucy Wingate, in June 1939. He later flew Martin B-10 bombers and, at Savannah, Douglas A-20 aircraft. In his spare time he hung out with his golfing partner, the future General George Patton.

In 1941, Tibbets was selected for training on the new Boeing B-17 bomber and later participated in Operation BOLERO, an aircraft-ferrying operation from the United States to the United Kingdom. As commander of the 340th Bombardment Squadron, 97th Bombardment Group, he participated in the first U.S. air raid in Europe on 17 August 1942, flying the B-17E *Butcher Shop.* By then, he had made major and begun to distinguish himself as an able commander. Although not above micromanaging his men, his meticulous checks on equipment actually helped train them better and may have saved their lives as they learned to fly according to his exacting standards.

In October 1942, Tibbets was promoted to lieutenant colonel and assigned to Operation TORCH, flying Lieutenant General Mark Clark to meet with French General Emmanuel Mast in Morocco. However, Tibbets's time in North Africa was cut short by his conflict with Major General Lauris Norstad. A disagreement over the risk Tibbets's men were being told to take in bombing at low altitude prompted the general to demand a court-martial for insubordination.

Tibbets's allies in the upper levels of command managed to transfer him back to the United States in March 1943, where he began familiarizing himself with a new bomber experiencing growing pains—the Boeing B-29 Superfortress. Tibbets eventually logged more than 400 hours with the plane, which made him one of the most experienced heavy bomber pilots in the Army Air Forces. By September 1944 Tibbets had been briefed on the Manhattan Project, the code name for the U.S. atomic bomb program, and was asked to prepare a special air unit that would be able to deliver such a weapon. He requisitioned 15 new B-29s and had them modified accordingly. His men came from the 393d Bombardment Squadron and were later incorporated into a new unit, the 509th Composite Group. Initially based in Utah, the group slowly moved out to Tinian Island in the Pacific, where on 5 August 1945 Tibbets received presidential clearance to use the first of two atomic devices that were ready.

On 6 August 1945, Tibbets piloted the B-29 *Enola Gay* (named after his mother) and flew to Hiroshima, where the uranium bomb code-named "Little Boy" detonated at 8:15 A.M. local time. Upon his return, Tibbets received the Distinguished Service Cross.

After the war, Tibbets remained in the service and participated in the Bikini Atoll atomic-bomb test. He then became involved in a variety of assignments, ranging from overseeing the acquisition of the Boeing B-47 Stratojet bomber (1950–1952) to serving at NATO headquarters in Paris. After his retirement from the U.S. Air Force in 1966 as brigadier general, Tibbets flew private jets in Geneva, Switzerland, then from 1970 to 1985 worked for Executive Jet Aviation in Columbus, Ohio, retiring as chairman of the board. When asked in interviews about his views on Hiroshima, Tibbets always expressed the opinion that he had done his duty and that his actions helped shorten the war.

In the 1995 controversy over the Smithsonian exhibition of the *Enola Gay,* Tibbets remained somewhat aloof of the passions generated by the proposed exhibit. He did call for the plane (which he had last flown to a storage area in Illinois) to be exhibited with a simple sign and no historical exhibits around it, similar to the display at the U.S. Air Force Museum in Dayton, Ohio, of the B-29 that bombed Nagasaki.

Guillaume de Syon

See also
Hiroshima; Nagasaki

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Tokugawa, Yoshitoshi (1882–1963)

Japan's premier aviator. Born in Tokyo on 23 July 1882, he became in 1908 the first person to make a balloon flight in Japan. As a student of the imperial military school, he was chosen along with several other students to travel abroad to study aviation. Japanese militarists quickly realized aviation's potential in warfare and decided to send students to Germany, the United States, and France, the three nations that were leaders in aviation at that time. In addition to learning to fly, students were authorized to purchase planes for the imperial forces.

Tokugawa went to France to learn aviation at the school near Paris established by the Farman brothers. Tokugawa purchased a Henry Farman biplane and successfully flew it sometime in mid-1910. Tokugawa obtained his international pilot's license on the Farman biplane on 8 November 1910, procuring one of the first 300 international licenses. This flight, although undoubtedly not his first, is his first documented solo flight and garnered him the distinction of the first Japanese heavier-than-air pilot.

Tokugawa returned to Japan in December 1910. In recognition for his achievement, the government honored him with the rank of captain of imperial exercises. He demonstrated the Farman biplane on 19 December over the field of Yoyogi in central Tokyo. During this flight, Tokugawa flew over the celebrated Temple of Meiji, obtaining a view that no one else had ever attained. His flight lasted nearly an hour and marked the first flight of a heavier-than-air machine in Japan.

Tokugawa became a career officer with the imperial forces and initially retired in 1939. His last post was commander of the Aero Corps of Exercises. At the age of 57, Tokugawa was not quite finished with his military service, however. During World War II, Japanese militarists requested he leave retirement and direct the official school of aviation. Under his direction, this school was the training ground for many of Japan's aggressive fighter pilots.

After the war, he retired a second time. Retirement this time was more peaceful, punctuated only by a fiftieth-anniversary celebration of his first 1910 flight. In 1959, a year before the celebration, the United States Air Force returned Tokugawa's original Henry Farman biplane from its temporary home in the U.S. Air Force Museum at Wright-Patterson Field in Ohio. U.S. forces had removed the Farman during the occupation of Japan after World War II. Yoshitoshi requested the plane be displayed in the Museum of Military Pilots in Yasukuni in memory of the victims of World War II in central Tokyo. A lifelong Japanese pioneer in aviation, Yoshitoshi Tokugawa died in 1963.

Wendy Coble

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Tokyo Air Raids

Two major raids against Japan's largest city. The 18 April 1942 raid was launched to improve sagging U.S. morale early during World War II, as the country had been shaken by a string of costly defeats. Army-Navy cooperation in planning was excellent. Lieutenant-Colonel James Doolittle acted as army coordinator and led the mission.

Because Japanese picket ships were stationed 500 miles off the home islands, the plan was to launch the attack at 550 miles. Although U.S. Army B-25B Mitchell bombers could take off from carriers, they would not be able to return to them; after striking Tokyo they would fly to China. Among the modifications to the B-25s, equipment was removed and collapsible fuel tanks were added to allow a flight of 2,000 miles. Each plane carried four 500-pound bombs.

The carrier USS *Hornet* sailed from San Francisco on 2 April with 16 B-15s on its flight deck. None of the pilots had actually flown a B-25 off a carrier. The *Hornet* was joined on 13 April by the carrier *Enterprise* to provide air cover. Task Force 16 consisted of the two carriers, four cruisers, eight destroyers, and two oilers.

The Japanese were aware from radio traffic that something was in the offing. Combined Fleet Headquarters ordered naval aircraft concentrated in the Tokyo area and alerted picket boats offshore. Early on 18 April, about 650 miles off the Japanese coast, one of these ships gave the alarm by radio, although it was promptly sunk; the original plan to launch the B-25s off on the afternoon of April 19 had to be scrapped. Task Force 16's commander, Vice Admiral William Halsey, ordered an immediate launch. Doolittle's B-25 was the first plane off, at 8:20 A.M.; all were away by 9:20 A.M. Task Force 16 then steamed away at flank speed.

The attack achieved total surprise because the Japanese assumed an attack range of 200 miles and hence a later launch. No bombers were downed over Japan, and only one was hit by ground fire, although all were subsequently lost because the Chinese airfields were not ready to receive them and the crews had to bail out or crash-land. One plane landed at Vladivostok and was interned. Three crewmen died of injuries, and eight were captured by the Japanese. The captured were subsequently tried on charges of bombing and strafing civilian targets. Three were executed; four others survived the war.

The raid inflicted little material damage. Doolittle was presented the Medal of Honor and jumped two ranks to brigadier general. The famed Doolittle Raid and other U.S. carrier attacks had far-reaching effects. A boost to American morale, they were an embarrassment to the Japanese, led to the shift of four fighter groups to defend Tokyo and other cities, and brought a Japanese army punitive expedition in China that killed perhaps 250,000 Chinese. It also increased support in Tokyo for pushing the outer defensive ring farther and drawing out the U.S. Fleet. This culminated in the June 1942 Battle of Midway.

Later in the war, the arrival of the new B-29 bombers in the Pacific brought the opportunity to strike Tokyo. Initially operating from India and China, with the July-August 1944 capture of Saipan, Guam, and Tinian, the B-29s moved there. On 25 November, the United States launched its first attack on the Japanese capital since the Doolittle Raid; 110 Superfortresses were sent against the Nakajima aircraft-engine manufacturing plant in the Tokyo suburbs, but only 24 of the planes bombed the primary target.

The B-29 was a superb aircraft, but to carry 3 tons of bombs 1,200 miles to Tokyo and back consumed 23 tons of gasoline. Precision bombing was impossible at 30,000 feet, and jet streams and crosswinds caused tremendous problems. It also had engine and other problems common to any new aircraft.

Although early B-29 raids affected worker morale and forced the Japanese to disperse industrial activity, the loss rate was running at an unacceptable 6 percent per mission, and General Henry W. "Hap" Arnold brought in Major General Curtis LeMay, who developed new tactics. These resulted from a successful 25 February 1945 raid on Tokyo involving 231 bombers with a mix of general-purpose and incendiary bombs that burned out a full square mile of the Japanese capital.

LeMay decided to send the B-29s in low at night, stripped of defensive armament save the tailgun. As most Japanese structures were of wood, he would use M-47 and M-69 firebombs rather than demolition bombs, and the planes would bomb at 5,000–8,000 feet. Removing machine guns, ammunition, and gunners more than doubled the bombload. His crews were astonished and believed they would be slaughtered. But the Japanese did not have radar and would have to locate the fast-flying B-29s with searchlights.

On the evening of 9 March, 334 B-29s carrying nearly 2,000 tons of bombs (average bombload, 6.6 tons) took off to bomb four designated aiming points in Tokyo. Some 325 B-29s reached the target in the early hours of 10 March. Forty-two were hit by antiaircraft fire and 14 were lost.

Firestorms exceeding 1,800 degrees Fahrenheit ("the flowers of Edo" was the poetic Japanese phrase for the events) burned out more than 15 square miles of the city. Official Japanese figures list 83,793 dead and 40,918 injured, but the actual total was probably higher. The destruction of 267,171 buildings left 1 million people homeless, and 18 percent of Tokyo's industry was gone. The firebombing of Tokyo was subsequently repeated over other Japanese cities. More than 60 were hit, destroying 3.1 million homes, killing 1 million people, and rendering 14 million more homeless.

The firebombing of Tokyo and other Japanese cities did not by itself bring the Japanese surrender that LeMay had sought, but the B-29s destroyed Japan's warmaking capacity, had a devastating effect on Japanese morale, and weighed heavily in the leadership's decision to sue for peace. After the Tokyo raid of 10 March, there could be no doubt that Japan had lost the war.

Spencer C. Tucker

See also

Boeing B-29 Superfortress; LeMay, Curtis E.

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Top Gun

During the Vietnam War, the U.S. Navy discovered that its fighter pilots had a 3:1 kill ratio. To improve this figure, the

Navy established an elite school for the top 1 percent of its pilots, its purpose to teach the art of aerial combat. The Navy calls it the Naval Strike and Air Warfare Center; pilots call it Top Gun.

Top Gun improves a pilot's sense of self-confidence and graduates the best fighter pilots in the world. This takes place through intensive training. By 1972, pilots trained at Top Gun were achieving a 13:1 kill ratio.

To qualify for Top Gun a pilot must have at least 500 flying hours, at least one tour on an aircraft carrier, and show high leadership skills. During the five weeks of school, the students attend classroom training and have about 100 flights against the "enemy." Upon graduating they return to aircraft carriers and train the other pilots in their squadron in advanced fighter tactics. During the flying exercises, instructor-pilots try to take advantage of the student's weaknesses. The students will learn that it takes teamwork to beat the enemy.

Every move the airplanes make is recorded and sent back to the Air Combat Management Range. When the pilots return to base they review the electronic records of their flights. They then analyze the whats, hows, and whys of their flights. In this way they learn how to improve performance for the next flight.

The highlight of the course is the Alpha Strike. This is a full-scale simulated battle between instructors and students. The students try to attack a land-based target, and the instructors try to intercept and eliminate the attackers before they can reach the target.

Henry M. Holden

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TORCH (1942)

Allied code name for operation to support the amphibious invasion of French North Africa. On 8 November 1942 Allied forces landed at Safi, Rabat, and Port Lyautey in Morocco, and at Algiers and Oran in Algeria. The British air base at Gibraltar, overflowing with aircraft, provided a base for Allied air cover from the RAF's Northwest Tactical Air Force and the USAAF's Twelfth Air Force. This was provided primarily by British Bristol Bisley (Blenheim V) and U.S. Boeing B-17, North American B-25, and Martin B-26 bombers. Twin-engined Lockheed P-38s and Bristol Beaufighters also proved particularly useful because of their long range.

These aircraft were supplemented by carrier-borne planes flying from the USS *Ranger* and five escort carriers off Morocco plus the British carriers *Victorious, Formidable, Argus,* and *Furious* and several auxiliary carriers off the Algerian coast. A German submarine sank the escort carrier HMS *Avenger.* This was one of the few direct uses of carrier aircraft in support of ground operations in the European theater.

French resistance was variable, but the Vichy air forces responded with interception of Allied aircraft with Dewoitine D.520 fighters and several strikes against the beaches and ships offshore. German and Italian aircraft from Sicily and Sardinia also attacked Allied invasion shipping.

Although Gibraltar was too far from the Algerian landing zones to allow for fighter cover, the base allowed for the staging of single-engine fighters to North African bases. Capture of the French airfields at Maison Blanc outside Algiers and La Senia and Tafaroui near Oran allowed fighter aircraft to ferry in from Gibraltar.

An attempt to fly U.S. paratroops from Britain across neutral Spain to land at captured airfields near Oran was not successful; poor navigation spread U.S. Douglas C-47 transports from Spanish Morocco to eastern Algeria, and very few men were delivered to the correct destinations.

French resistance soon ceased, but by then Axis air forces had begun transferring to Tunisia. Lack of advanced bases and poor weather hindered Allied air forces' support of attempts to take Tunisia. In early 1943, however, Allied air forces successfully shut down Axis naval resupply routes. The Axis resorted to aerial resupply attempts by Italian and Axis transports, including the huge six-engined Messerschmitt Me 323 "Gigants." Although partially successful for a time, these operations resulted in heavy losses in Axis transport aircraft and were ultimately doomed. The last Axis troops in Africa, cut off by Allied air and naval power, surrendered on 12 May 1943.

Frank E. Watson

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Towers, John H. (1885–1955)

U.S. Navy admiral. Born on 30 January 1885 in Rome, Georgia, Towers graduated from the U.S. Naval Academy in 1906 and became naval aviator No. 3 in 1911. He spent 1914–1916 in London, surreptitiously saw combat on the Western Front, and returned to Washington to oversee naval aviation's wartime expansion.

Commander Towers achieved fame leading the Navy's

In wartime you do what you have to do—and for this Curtiss P-40 pilot it means taking off from a carrier to participate in the invasion of North Africa. (U.S. Air Force)

transatlantic flight, accomplished by Lieutenant Commander Albert C. Read, with NC-4 in May 1919. After shore service and further London attaché duty, he served on the Morrow Board and was successively executive officer and captain of the carrier USS *Langley* until 1928. Staff duty followed and he was promoted captain in 1930.

Towers commanded USS *Saratoga* (1937–1938) and then was assistant chief and, as rear admiral, chief of the Bureau of Aeronautics until 1942. Working with leaders in government and industry, he played a key role in crafting naval expansion, increasing U.S. and Allied airpower, and improving war mobilization.

In October 1942, Vice Admiral Towers became commander of the Air Force Pacific Fleet at Pearl Harbor with Admiral Chester W. Nimitz. A crucial member of Nimitz's inner circle, he overhauled and oversaw the strategic, doctrinal, and logistical requirements of the Navy's carrier-centric transpacific offensive against Japan. Symbolically, he took command of Task Force 38 the day before Japan signed surrender documents.

In October 1945, Towers was promoted to admiral, then became commander in chief of the Pacific in November. After further Washington service, he retired in December 1947 and became a member of the board of Pan American Airways. He retired in September 1953 and died in New York on 30 April 1955.

Paul E. Fontenoy

See also

Arnold, Henry H. "Hap"; Bureau of Naval Aeronautics; Halsey, William F.; McCain, John S.; Mitscher, Marc Andrew; Moffett, William Adger; Nimitz, Chester William; Spruance, Raymond A.; Task Force 38/58

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Trenchard, Hugh (1873–1956)

Considered to be the father of the Royal Air Force.

Hugh Montague Trenchard (nicknamed "Boom" because of his deep voice) graduated from Sandhurst and entered army service in 1893, seeing active service during the Boer War (1899–1902), during which he was wounded. He became interested in aviation later in life, being taught to fly in 1912 by Thomas Sopwith at Brooklands in but 10 days, soloing just four days before his fortieth birthday. At that point his career began to move quickly. As a major, he was assistant commandant of the central flying school (Upavon, 1913–1914). A year later as a colonel, he was commandant of the administrative wing at Farnborough. From 1915 to 1917 as a general, he was in charge of all Royal Flying Corps activities on the Western Front. He was knighted in 1918.

Even though he did not learn to fly until almost 40 years of age, Hugh Trenchard is considered the father of the Royal Air Force. (U.S. Air Force)

On 1 April 1918, the Royal Flying Corps and Royal Naval Air Services were combined to create the Royal Air Force, with Trenchard as its Chief of Air Staff under Lord Rothermere as secretary of state. Just weeks later the two had a falling out and Trenchard resigned, returning to Europe as chief of the Inter-Allied Independent Air Force responsible for the bombing of Germany.

Trenchard was called back as chief of the RAF by Winston Churchill in February 1919. Both men agreed that military aviation needs had to take priority over civil developments. On 13 December 1919, Trenchard issued a white paper describing the future of the RAF—what Sir Samuel Hoare called "a constitution for a new fighting service"—with a major emphasis on training, rebuilding after postwar demobilization, developing research, establishing auxiliary (reserve) squadrons, and setting up training programs within universities. The paper became a blueprint for the RAF's formative years.

He promoted the use of military aviation as a means of patrolling British-controlled Iraq in 1920, calling it "control without occupation" to help cut costs. He established the air force college at Cranwell, as well as a permanent air staff, and pushed for large bombers and more squadrons. His RAF provided just enough contracts to British aircraft firms to keep key design teams intact, though few production contracts resulted. Trenchard became the first Air Marshal in 1919, Air Chief Marshal in 1922, and Marshal of the RAF in 1927. Upon his retirement in 1930, he was created a baron.

From 1931 to 1935, Trenchard served as commissioner of the London metropolitan police and helped to establish a training school at Hendon. There were complaints that he was militarizing the service.

He retired, was created a viscount in 1936, and until 1953 served as chairman of United Africa Company. He died in 1956 and is buried in Westminster Abbey.

Christopher H. Sterling

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Truman, Harry S.

Became U.S. president after the death of Franklin D. Roosevelt in 1945; made the decision to drop the atomic bomb and to defend Korea. He was reelected to a full term in 1948. In the years following World War II, Truman oversaw the dismantling of U.S. military forces on a spectacular scale. Although he would, to some extent, continue Roosevelt's "world policeman" policy, Truman recognized that large numbers of conventional forces spread around the globe would be too demanding on the U.S. economy. He believed that strategic airpower coupled with nuclear weapons would provide fiscally responsible military capability and serve as the foundation of national security policy (an idea that would later be developed more thoroughly into the "new look" under President Dwight D. Eisenhower).

As part of the National Security Act of 1947, Truman established the Air Force as a separate military service. Truman's blue-ribbon Finletter Commission confirmed the value of strategic airpower at the expense of tactical forces and dwindling expenditures for the other services. Throughout the postwar years, Truman sided with the Air Force during critical budget and policy battles. He tacitly approved the purchase of Convair B-36s and concurrent cancellation of the USS *United States* aircraft carrier as part of the interservice wrangling during the so-called revolt of the admirals.

Truman embraced the use of cargo aircraft rather than a troop convoy to support Berlin during the October 1948 crisis. Moreover, he rattled the nuclear saber by deploying "atomic-capable" Boeing B-29s to England (the airplanes had in fact not been converted to carry atomic weapons; neither were atomic weapons deployed—it is unclear if the Soviets were aware of this bluff). By 1949, Truman's commitment to strategic nuclear airpower increased with the loss of China to communists under Mao Tse-tung. Aware that conventional U.S. forces were ill-prepared and numerically incapable of fighting the Chinese in a land war, Truman reiterated his support for strategic airpower by approving an increased budget for the Strategic Air Command at the expense of other commands and armed services—another policy extrapolated under Eisenhower.

Two critical events altered Truman's view toward military spending but did not diminish his predilection toward airpower: the adoption of National Security Council Directive NSC-68 and the onset of the Korean War. NSC-68 warned of inadequate conventional and tactical military forces to protect U.S. global interests, a situation that could be remedied only by procuring more tanks, naval vessels, and troops. The June 1950 North Korean invasion of South Korea illuminated the limits of strategic nuclear airpower in the face of regional conflict. Consequently, Truman approved larger defense budgets for tactical weapons, including a much-needed boost in naval and Marine tactical air forces. Despite this, strategic airpower—and SAC in particular—remained the cornerstone of Truman's military power and national security policy.

Robert S. Hopkins

See also

Airlift Operations, U.S.; Atomic Bomb; Berlin Airlift; Consolidated B-36 Peacemaker; Finletter Commission; Korean War; Massive Retaliation; National Security Act of 1947; Strategic Air Command; United States Air Force, Organizational History; Vandenberg, Hoyt S.

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TsAGI

The Soviet Union's Central Institute for Aerodynamics and Hydrodynamics (Tsentral'nyi Aero-Gidrodinamicheskii Institut). Nikolai Yegorovich Zhukovsky, the acknowledged father of Russian aviation, founded TsAGI in December 1918. It formed the scientific foundation for Soviet aircraft designs throughout the twentieth century. Zhukovsky, born in 1847, had already distinguished himself as a mathematician and engineer. He worked with Otto Lilienthal and purchased several Lilienthal gliders to use in his work in the early 1900s. Zhukovsky remained in Russia after the 1917 revolution and established the Flight Laboratory at the Moscow Higher Technical School. It was the merger of the Flight Laboratory with Red Air Fleet aircraft designers that formed TsAGI. Andrei N. Tupolev, one of Zhukovsky's best students, was among those who helped coordinate Soviet aircraft production. In addition to testing aircraft from other designers, TsAGI scientists also conducted extensive wind-tunnel tests on their own aircraft designs and worked on all elements of flight and high-speed vehicles.

As aircraft speeds increased during the 1930s, TsAGI engineers found that their wind tunnels were inadequate to simulate the real stresses the new monoplane designs encountered. If it was to build more powerful tunnels, TsAGI had to move its facilities out of Moscow to a city specially constructed for aeronautical engineering. Originally named for the man who exceeded his coal-mining norm, Stakhanov, TsAGI's new city was renamed Zhukovsky after the institute's founder. Even as TsAGI itself expanded, it also spun off new research facilities manned by its former scientists.

The German invasion of Russian on 22 June 1941 meant that TsAGI staff had to focus on rapidly clearing new aircraft to defend the Soviet Union, but it continued its research mission all the same. This work continued despite the evacuation of the facilities to Kazan and Novosibirsk. When the German defeat allowed TsAGI to relocate back to the Moscow area, a new research institute was left in place back in Siberia.

After the war, TsAGI helped develop the jet engines and airframes that made the MiG-15 and MiG-21 such lethal foes in the Korean War and Vietnam War. In addition to advanced jet fighters, TsAGI personnel helped develop Soviet strategic bombers and rockets throughout the Cold War. Research into variable-geometry wings for the MiG-23 and Su-24 helped computerize the evaluation process to a greater degree. The excellent aerodynamics and maneuverability of the MiG-29 and Su-27 owe much to TsAGI facilities. TsAGI did not focus exclusively on military aircraft; it also tested passenger aircraft such as the Il-96 and Il-114.

The collapse of the Soviet Union left the Russian Federation short on the resources needed to keep TsAGI at the cutting edge of science and technology. Like the air force that it so successfully supported for more than 80 years, TsAGI's future is difficult and uncertain.

Mark A. O'Neill

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Tsiolkovsky, Konstantin Eduardovich (1857–1935)

Russian-born pioneer in rocketry. Konstantin Tsiolkovsky was born on 17 September 1857 in the town of Izhevskoye. At the age of 10, he almost lost his hearing completely. Isolated from his peers, he delved into reading and speculative thinking. This led to an interest in mechanical flight and aerostatics.

As a high school mathematics and physics teacher for 40 years, he conducted studies and experiments mostly at home with small grants from the Academy of Science and others.

In 1885 at age 28, he devoted his energies to aeronautics and the theoretical development of a metal dirigible. As a result, he published, "Maneuverable Metal Dirigibles" (1892) with the help of his brother and friends. A follow-up article comparing airplanes and dirigibles appeared two years later. In 1899, he examined air resistance in "Air Pressure Upon a Surface in an Artificial Flow of Air."

In 1903, his first article on rocketry, "Exploration of Space With Rocket Devices," appeared in *Scientific Review.* That same year, he drafted the design of his first reaction-thrust model rocket utilizing liquid hydrogen and liquid oxygen to reach the limits of space. Since a tremendous amount of fuel was required to reach escape velocity, he was convinced that multistage rockets were required. During the 1920s, he expanded on these theories in more than 60 works. In 1918, he was elected as a member of the Soviet Academy. He retired from teaching at age 64 to devote his remaining years to rocketry. Space pioneers Sergei Korolyov, Hermann Oberth, and Wernher von Braun have hailed him as a prophet and an influence.

Colin A. Fries

See also

Korolyov, Sergei; von Braun, Wernher

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Tunner, William H. (1906–1983)

U.S. Air Force airlift specialist. William H. Tunner was born on 14 July 1906 in Elizabeth, New Jersey. He graduated from the United States Military Academy in 1928 and went on to complete Advanced Flying School the following year. In 1941, Tunner helped organize the Army Air Corps Ferry Command. Promoted to colonel in 1942, he became commanding officer of the Ferrying Division of the Army Air Forces Air Transport Command, where he was responsible for the safe delivery of thousands of aircraft per month to Allied air forces.

In September 1944, Brigadier General Tunner took over the India-China division of Air Transport Command. Under his driving leadership, tonnage flown over the treacherous Hump air route between India and China rose sharply. This wartime service established Tunner as the military's premier airlifter.

Tunner was called upon to direct the aerial supply of Berlin in 1948–1949 as head of the Combined Airlift Task Force. Emphasizing centralized command, standardized flying procedures, and strict crew discipline, he shaped the airlift into a model of efficiency. The tonnage that his airmen poured into the isolated city proved the key to victory over the Soviet Union in the first direct confrontation between the two superpowers during the Cold War.

Shortly after the outbreak of war in Korea in 1950, Tunner was assigned to the Far East Air Force as head of Combat Cargo Command. For a third time in his career, he applied his organizational skills to the creation of a massive airlift effort, this time in support of United Nations forces during the critical early months of the conflict.

Attaining the rank of lieutenant general in 1953, Tunner became commander in chief of United States Air Forces in Europe. Between 1958 and 1960, he served as head of the Military Air Transport Service, where he waged a largely unsuccessful battle for increased funding to enhance airlift capabilities. Only later would the wisdom of his advice be recognized.

William M. Leary

See also
Berlin Airlift; Combat Cargo Command; Hump Airlift

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Tupolev Aircraft

One of the most important and earliest Soviet aircraft design bureaus, specializing in multiengine aircraft. In addition to its own numerous creations, Tupolev also gave birth to many of the other major Soviet design teams, including Sukhoi, Arkhangelskii, Petlyakov, Myasishchev, and others, whose chiefs and designers began their careers working under Tupolev.

Origins and Early Models

Andrei Nikolaevich Tupolev was born on 10 September 1888, the son of a lawyer active in revolutionary politics, and was himself briefly arrested in 1911. Interested in engineering, Tupolev in 1908 began to study under Nikolai Zhukovsky, the father of Russian aviation, and by the time of the revolution had become his chief assistant. Both men, with leftish sympathies, cast their lots with the Bolsheviks, and together in 1918 they founded TsAGI (Central Institute for Aerodynamics and Hydrodynamics), which became the agency responsible for directing the work of all the aviation design teams in the Soviet Union and conducting all test-flying.

In 1922, Tupolev completed his own first aircraft design, the tiny ANT-1 metal monoplane with a 35-hp engine. In 1924, he completed his second design, the ANT-2, a single-motor small transport reminiscent of the Junkers K 16. In both designs Tupolev used a new material for construction, Kolchug, a derivative of duralumin. Corrugated Kolchug construction became a Tupolev trademark until the mid-1930s.

Tupolev's first series produced design was the ANT-3 (R-3) single-engine reconnaissance biplane designed in 1925. In 1926, one of the preproduction examples made a goodwill tour of the major European capitals, the first Soviet-designed aircraft seen by the outside world. Between 30 August and 2 September, it covered a circuit of 4,443 miles in 34 hours, 15 minutes of flying time. From 1927 to 1929, 100 R-3s were produced, and they became the first Soviet-designed aircraft to see combat, flying attack missions against the Basmachi in the Central Asian Soviet Republics. At about the same time, Tupolev designed his first multiengine aircraft, the TB-1, a twin-motor corrugated Kolchug bomber whose appearance foreshadowed its younger and larger brother, the TB-3.

The TB-1 first flew at the beginning of 1926; 217 were built, including 66 with float landing gear. Though the TB-1 never saw combat, some remained in second-line use as transports throughout World War II. About this same time, Tupolev designed the ANT-5, a sesquiplane fighter that went into service as the I-4. Thus, within five years of his first struggling design Tupolev had given the Red Air Force a tactical bomber, a fighter, and a heavy bomber—all accepted into series production.

From this time on, Tupolev became a specialist in multiengine designs while Polikarpov specialized in single-motor aircraft. Tupolev's next design made history, though it brought undeserved ridicule during the war. Design of the ANT-6 began at the start of 1926, and in February 1931 it made its first flight.

This aircraft, which went into production at the end of 1931, was the world's first four-engine all-metal heavy bomber. Four motors, huge fixed landing gear, and the classic Tupolev corrugation provided strength, a speed of about 180 mph, and a range of 620–840 miles, depending on the subtype. Its original purpose was to provide long-range air support to the proletarians of the western cities, whom communist strategists of the 1930s expected would revolt at the start of the anticipated next war. The occasion and circumstances of that war proved different, and when it came both the Axis and the Western Allies derided the TB-3's obsolete appearance and performance. Still, hundreds of TB-3s were in service before the first Boeing 299 flew, and production of 819 TB-3s had been completed before a single B-17 was accepted for service.

During the summer maneuvers of 1935, hundreds of TB-3s performed the world's first mass parachute drop near Kiev before German paratroops had even made a practice jump. The TB-3 flew bombing missions against the Japanese at Lake Khasan in 1938 and at Khalkin Gol in 1939, and in

1938 six were given to the Chinese, who used them mainly for transport. During the Winter War against Finland, the TB-3 flew a number of missions against Helsinki, mostly at night.

During the difficult days of June-July 1941 the TB-3 did fly unescorted low-level daylight bombing missions against the advancing German panzers, but this was in desperation; by late summer the survivors had returned to night operations. On other occasions in 1942, TB-3s were used in badly mishandled Soviet paratroop drops. For the rest of the war they continued in the valuable job of transport. Some were still in service in August 1945 and supported the brief war against Japan.

On the heels of the TB-3, Tupolev in 1934 designed the even bigger ANT-20, the Maxim Gorky, a monster with six engines mounted on the wings and two more mounted in tandem on a pylon above the fuselage. This aircraft was intended to be the center of a propaganda squadron, but further development was abandoned when it was destroyed in a midair collision with an escorting fighter during an air show. Advanced work was begun on an even more ambitious project, the ANT-26, which would have featured eight engines mounted on the wings and four engines mounted in two pylons over the wings. This project was never completed. Other important long-range projects designed by Tupolev were the ANT-25, a long-range single-engine aircraft that achieved fame during the 1930s for several world-record flights, including the first cross-polar flight to the United States. Another distance aircraft was the twin-engine ANT-37, originally designed as a bomber; one of the developmental examples was named *Rodina* and flown by Grizodubova, Osipenko, and Raskova on their historic distance flight of 24 September 1938.

After the TB-3, Tupolev's next military design to enter service was the ANT-40 (SB), generally but incorrectly known as the SB-2. This was a fast bomber (for which "SB" is the Russian abbreviation) introducing a number of new features for a Tupolev design: stressed-metal construction instead of corrugated, retractable landing gear, and enclosed crew stations. The SB entered service in early 1936 and a few months later saw its first combat over Spain.

Known to the Soviet and Republicans as "Katyuska," the Nationalists called it the "Martin," unable to accept that such a modern design could have originated with the backward Russians. Initially the SB could be overtaken by opposing fighters only if was caught unawares and they could dive from above before it accelerated. Only with the arrival of the Bf 109 was the SB at serious risk. It saw combat against the Japanese in China from 1937, flown by Soviet volunteers and in significant numbers by Chinese crews, as well as at the clashes over Lake Khasan and Khalkin Gol. It was the main bomber used over Finland in 1939, but by then the SB was starting to show its age. Unfortunately for the SB's reputation, it still constituted the overwhelming majority of Soviet bombers at the time of the German invasion and by then was outdated. Perhaps it could have managed with an effective fighter escort, but such was not to be had in 1941 and 1942, and the SBs were massacred until relegated to nighttime missions. By late 1942, almost all had been withdrawn from action against the Germans, though the Finns continued to fly a number of captured examples until their surrender in 1944. However, others continued in service in quiet areas, and even in August 1945 a few of the 6,831 SBs built remained in service to bomb the Japanese one last time.

During the 1930s, the Stalinist purges unjustly executed millions and jailed millions more, including thousands of the country's leading military, industrial, and scientific elites. Andrei Tupolev was no exception, but he did receive exceptional treatment. He was arrested on 21 October 1937 and charged with providing the Germans with plans for the Bf 110, incredible as that sounds. About the same time, most of his senior designers and assistants were also arrested. However, instead of being shot or sent to a death camp in northern Siberia like so many others, Tupolev and his engineers were treated relatively gently and confined to a special prison in Moscow where they continued their work designing combat aircraft.

The result of this labor was the Tu-2 twin-motor bomber. With the success of this design, Tupolev was freed in July 1941, followed by the other designers. In 1943, he was awarded the Stalin Prize for this design. The Tu-2 flew shortly before the German attack, but development was delayed by a lack of suitable engines and then by the industrial displacement of the war. The first small batch was accepted for service in February 1942, but production delays and training difficulties limited its use, and only by 1944 did the Tu-2 begin to reach the front in significant quantity. By the end of the war, 1,013 had been produced. postwar production continued until 1949, when the total had reached 2,527, plus a number of trainers. During the late 1940s, the Tu-2 was supplied to the air forces of several Warsaw Pact countries. From 1950, the Tu-2 was supplied to China and later to North Korea. These Tu-2s saw combat on a couple of occasions, being badly mauled by F-86s.

Post–World War II

During 1944, the Soviet Union acquired three B-29s that had been forced to land in the Far East after missions over Japan and kept them instead of returning them to the Americans. Stalin ordered that they were to be disassembled and that a reverse-engineered exact copy should be produced for the Soviet air force. Although Tupolev argued that it would be easier and better to use the information gained to produce a new and better original design, Stalin insisted that everything be copied except for substituting Soviet standard machine guns. The resulting aircraft was designated the Tu-4 (NATO code name "Bull") and entered service with Soviet Long Range Aviation in 1948. Between 1947 and 1951, 847 examples of the Tu-4 were produced, of which 24 were later provided to China. Incapable of reaching the United States, the Tu-4 did pose a threat to positions in Europe and the Far East and gave the Soviets their first experience of a genuine independent strategic bomber force and capability of carrying nuclear munitions. From the early 1950s, it was gradually replaced by Tupolev's original designs.

The first of these new Tupolev designs was the Tu-16 (NATO code name "Badger"), which entered production in 1953 and shocked the world when it appeared over Red Square in 1954. This was a twin-jet swept-wing bomber with the engines located in the wing roots and was capable of carrying nuclear or conventional weapons at a speed of about 650 mph over a range of 3,580 miles. Later variants were able to extend range through inflight refueling, and some Tu-16s were converted to aerial tankers to provide that capability. Modified versions were able to carry air-launched cruise missiles. From the beginning, the Tu-16 entered service with both Long Range Aviation and the naval air force, and production continued until 1965, when it was terminated on the order of Nikita Khrushchev, who wanted to shift emphasis to missiles. Production reached 1,511 Tu-16s, plus several hundred more manufactured in China as the B-6. During the 1970s, many Tu-16s were reengineered and updated to carry newer cruise missiles, to serve as electronic-warfare and reconnaissance aircraft, and to perform still other tasks.

In the early 1950s, a modification of the Tu-16 gave the Soviet Union its first civilian jet airliner. During the 1960s, large numbers of Tu-16s were exported to Soviet allies. In addition to pattern aircraft delivered to China in 1959, Indonesia received 26 Tu-16s, of both the bomb- and missile-carrying variants. Egypt received about 60 Tu-16s during its alliance with the Soviet Union, the first batch being wiped out on the ground in 1967, the others seeing action during the Continuation War and in 1973. Iraq received more than 20, and these flew some missions against Israel and then Iran. They were finally finished off during the 1991 Gulf War. In Soviet service, Tu-16s were active throughout the Cold War, patrolling near NATO borders, shadowing the U.S. fleets, and sometimes making dummy attacks on aircraft carriers. During the mid-1980s, they flew combat missions over Afghanistan; for this purpose, the missile carriers were retrofitted with conventional bomb racks. The Tu-16 remained in service until 1994.

Although the Tu-16 was intended as a theater bomber, the Tu-95, sometimes in the West mistakenly called the Tu-20, was a true intercontinental bomber. At a time when U.S. bombers had switched to swept wings and jet engines and had virtually abandoned defensive guns, the Tu-95 featured a unique combination: a swept wing, four huge turboprop engines with contrarotating propellers, and three gun turrets each with twin 23mm cannons. Western analysts immediately dismissed the plane (NATO code name "Bear") as an example of backward Russian technology. They felt much more threatened by the Myasishchev jet bomber (NATO code name "Bison"), which appeared a year earlier. In truth, they had it backward. Only 125 Bisons were produced between 1954 and 1962; the Bear, in 18 variants, remained in production until 1994, with about 400 airframes produced and many older airframes rebuilt and modernized, and it remains in useful service into the twenty-first century with no retirement date. The initial version of the Tu-95 carried free-fall nuclear bombs, but later versions were armed with a variety of nuclear and/or explosive cruise missiles. From 1960 to 1969, 53 Tu-95RTs (Bear D) were built for Soviet naval electronic reconnaissance, and their shape became even stranger with the addition of a huge bulbous pod under the belly. These aircraft became regular companions of U.S. carrier groups.

The last bombers, the Bear H, were built from 1980 to 1992, equipped with AS-16 cruise missiles. During the 1970s, another variant of the Bear appeared with a new designation—Tu-142 (Bear F). The Tu-142 was a major redesign and modernization of the original Tu-95, intended solely for the Soviet navy, which used it as a very-long-range antisubmarine-warfare aircraft, though during the 1980s a half-dozen were sold to the Indian navy; many of the 85 built for the Soviets remain in use. The very last version of the Bear was introduced into production only in 1989; 12 Tu-142MRs were built as strategic communications aircraft towing extremely-low-frequency cables to communicate with nuclear submarines on patrol. Although there were never as many Soviet bombers built or in service at one time as the West often feared, and though the Bear would have had trouble penetrating the NORAD system at its peak, it remains, alongside the B-52, one of the classic successes of Cold War aeronautics, loved by Russian pilots not even born when their bomber was built. An additional development of the Tu-95 must also be mentioned—the Tu-126. This was the Soviet Union's first AWACS aircraft; nine were built in the 1960s, serving until replaced by newer models in the 1980s.

During this period Tupolev designed more than just military aircraft. The Tu-16 was developed into the Tu-104, the first Soviet jet airliner, and the Tu-95 became the Tu-114, which gained fame transporting Khrushchev to New York in

1959. Together with a later series of jet airliners, the Tu-124, Tu-134, Tu-154 and Tu-204 have been built in big numbers—more than 2,300 aircraft, plus another 17 examples of the striking failure, the Tu-144 "Concordskii."

The intended successor of the Tu-16 was the Tupolev Tu-22 (NATO code name "Blinder"), a supersonic bomber with two engines mounted in pods above the rear fuselage. From 1960 to 1969, 311 were built, about half for the navy. The Tu-22 was built for free-fall bombing and as a missile carrier and also as an electronic-reconnaissance platform. During the 1970s, small numbers were provide to Iraq and Libya, the latter losing at least a couple during combat in Chad. A few Soviet Tu-22s, primarily the electronic-warfare versions, saw combat over Afghanistan, mainly in support of bombing missions by the Badger and Backfire. By the early 1990s, the type had been retired from service.

At the same time, Tupolev built one more fighter design, the Tu-128P (NATO code name "Fiddler"), a very-long-range missile-armed interceptor. Though an interceptor, it was large enough to be a Tupolev creation and bore a superficial resemblance to the Tu-22 Blinder. Between 1961 and 1966, 198 were built and then based at northern air bases with the mission of intercepting USAF cruise-missile carriers over the Arctic regions—long before they could get within launching distance of Soviet territory. The last of these aircraft were replaced during the late 1980s.

The next Tupolev bomber, known as the "Backfire" to NATO, again caused major controversies in the West. Even its designation has been controversial. Originally it was identified as the Tu-26, but Soviet sources insisted that it was the Tu-22M, a modified version of the Tu-22. However, Andrei Tupolev said that this was a deception strictly for political purposes. The Tu-22M Backfire has nothing in common with the Tu-22 Blinder beyond a design bureau. Backfire is a large transonic bomber with variable-sweep wings and is capable of carrying either conventional bombs or nuclear cruise missiles. When Backfire began entering service in small numbers in the mid-1970s, it caused near-panic in the West, and the United States alleged it was a new intercontinental bomber, pointing to its inflight refueling apparatus, and argued that even though the Backfire could not bomb the continental United States and return home, it could fly a one-way mission landing in Cuba or that the crews might be sent on one-way missions and sacrificed—not an implausible tactic in the event of a nuclear war. The Soviets dismissed these concerns as provocations and insisted that the Tu-22M was an intermediate-range bomber, a successor to the Tu-16 in the roles of European and Asian theater strike and naval cooperation. Finally, in the SALT II Treaty, the Soviets agreed to limit production of the Tu-22M to 30 per year and to remove the aerial-refueling apparatus. In the event, the Soviets did gain from the deception. The Tu-22M was produced until 1993, when about 500 had been completed, and it has seen combat of a sort unexpected by its designers (during the war in Afghanistan, subsequently against guerrillas in Tajikistan and Chechnya).

The final Tupolev bomber was the Tu-160 (NATO code name "Blackjack"), a variable-sweep supersonic bomber with intercontinental range. This bomber entered production only in 1989 as a replacement for the Tu-95 Bear, just as the Cold War Was ending. Although it is reported to handle and fly well, there have been persistent reports about incurable difficulties in its weapons, navigation, and electronic-warfare suites. Only 38 had been produced when the Soviet Union dissolved, and 20 were taken over by Ukraine, leading to a 10-year dispute over ownership between Ukraine and Russia. Eventually, lack of maintenance and the Tu-160's poor serviceability have defused the dispute.

During the postwar period, Andrei Tupolev remained active until almost the very end of his life. He died on 23 December 1972 and was succeeded by his son Aleksei as chief designer until 1992. With the end of the Cold War, Tupolev remains an active design bureau specializing in large aircraft but now concentrates on designing airliners.

George M. Mellinger

See also

Boeing B-29 Superfortress; Grizodubova, Valentina; Khalkin Gol Air Battles; Petlyakov Aircraft; Raskova, Marina Mikhaylovna; Spanish Civil War; Taran; Winter War

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Tuskegee Airmen

A famous unit of African American combat pilots who served during World War II. Despite pressure from the black press and the National Association for the Advancement of Colored People, African Americans were prohibited from serving in the Army Air Corps throughout the 1930s. In 1939, African Americans were admitted to the government-sponsored Civilian Pilot Training Program (CPTP), but no black graduates were allowed to enlist in the Air Corps. Finally, in January 1941 the Air Corps announced the formation of its first black combat unit: the 99th Pursuit Squadron. Training was to commence at a new Air Corps field to be built in the vicinity of Tuskegee, Alabama.

Listening intently to the great "Chief," C. Alfred Anderson, these men are history in the making: the Tuskegee Airmen. Third from the left is Benjamin O. Davis Jr., who would lead the Tuskegee Airmen into combat. (U.S. Air Force)

This location meant that black trainees would have to live and work within the heart of the unreconstructed South. Many loathed the segregationist precedent, but officials, as well as the pilots themselves, saw an opportunity to prove their critics wrong. The "Tuskegee Airmen" quickly received a flood of national media attention, and it soon became apparent that much was riding on their success or failure. They would operate under intense public scrutiny for the entire war.

Training of enlisted support personnel soon began at the Air Corps Technical School at Chanute Field, Illinois, and in July 1941 the first class of pilots began military aviation training at Moton Field. All were previous CPTP graduates, with the exception of Captain Benjamin O. Davis Jr., son of the first black general in the history of the U.S. military. The younger Davis had endured four years at the U.S. Military Academy before graduating in 1936, and in 1941 the Davises were the only two nonchaplain black officers in the regular Army.

Captain Davis was rapidly promoted to lieutenant colonel and, in August 1942, assumed command of the 99th Fighter Squadron. An AAF inspecting general reported in October 1942 that the 99th was in excellent condition and ready for immediate departure overseas, but the unit was permitted only to continue training; by early 1943 morale had suffered considerably. Finally, in April 1943 the 99th Fighter Squadron shipped out for North Africa.

By June, the 99th was operating over the Mediterranean, but Allied aircraft already dominated the area, and contact with Germans was infrequent. In July, the squadron downed its first enemy aircraft, but a long dry spell followed throughout the rest of 1943. This was not surprising given the circumstances, but opponents of the "Tuskegee experiment" recommended, based upon the supposed poor performance of the 99th, that it be reassigned to noncombat duties. This recommendation was endorsed by officials throughout the chain of command, all the way up to the commanding general of the AAF, General Henry "Hap" Arnold.

In October 1943, Colonel Davis argued before the War Department's Advisory Committee on Negro Troop Policies that the 99th's combat record was comparable to similar white units and, further, that it had accomplished this despite the unique pressures it had to operate under. Further attacks from AAF leadership were undercut by the obvious success of the 99th following its transfer to the more active Italian Theater.

On 16 January 1944, during intense combat in the skies over the Anzio beachhead, the 99th Fighter Squadron downed a total of eight German Fw 190 fighters, suffering the loss of two Curtiss P-40s. The squadron continued to perform well in the combat that followed, but by mid-February German air activity had again tapered off and the 99th returned to ground support. Throughout February and March, the 99th was gradually joined in Italy by the all-black 332d Fighter Group, which when fully deployed eventually comprised the 99th, 100th, 301st, and 302d Fighter Squadrons, all now under the command of Colonel Davis. The new squadrons of the 332d first deployed with obsolete Bell P-39s, but beginning in April they began to receive very capable Republic P-47 Thunderbolt. In late June, the 332d began its conversion to the top Allied air superiority aircraft of the day, the North American P-51 Mustang, and by the end of the summer the Tuskegee Airmen had assumed as their primary mission the job of escorting friendly bombers, often deep into the heart of Germany.

Throughout the rest of 1944, the 332d earned a reputation as one of the better fighter groups in Europe. Bomber crews soon coveted the protection of the "Red Tails" (as they affectionately became known, due to their P-51s' distinctive paint jobs), and in fact by war's end the 332d had the unique distinction of being the only fighter group to have never lost a bomber to enemy aircraft. By late 1944, it was apparent that the Tuskegee Airmen had earned the respect of their fellow white units; although individual acts of discrimination did continue, their treatment by the chain of command was on the whole fairly good. They received widespread and very positive publicity within the United States and were even visited by numerous celebrities, including Lena Horne and Joe Louis. Their success continued into 1945: During one March escort mission to Berlin, pilots of the 100th Fighter Squadron downed three of the new German Messerschmitt Me 262 jet fighters; during another escort mission the following month, P-51s of the 332d downed 12 German aircraft for the loss of only three of their own. During its peak period of combat, from August 1944 through April 1945, the 332d destroyed approximately 500 enemy aircraft in the air and on the ground. Tuskegee Airmen received numerous decorations for bravery, including the Legion of Merit, Silver Star, 14 Bronze Stars, and more than 150 Distinguished Flying Crosses; in March 1945 the 332d Fighter Group received the Distinguished Unit Citation. These accomplishments did not come without a cost, however: Of the approximately 1,000 black pilots trained at Tuskegee, 66 were killed in action, 32 were taken prisoner, and some 80 pilots and support personnel were killed in training and other noncombat accidents through 1946.

The combat record of the Tuskegee Airmen is remarkable given the obstacles they had to overcome: racism in the service, segregation, lack of opportunity, and discrimination at home. Through it all Colonel Davis was their leader, the cornerstone of their success.

But the fate of the 477th Bombardment Group, many of whose pilots were also trained at Tuskegee, provides a different and instructive example. The unit was moved numerous times during 1944 and 1945 without seeing combat. In April 1945, approximately 60 black pilots from the 477th were arrested for entering a white-only officers club at Freeman Field, Indiana; later, 101 officers of the 477th were arrested when they refused a direct order to sign a document essentially acquiescing to the segregation of officers clubs. A subsequent investigation concluded that white-only facilities violated Army regulations. Due in part to the so-called Freeman Field mutiny, the 477th was never allowed into combat.

Following the end of the war, the 332d Fighter Group gradually returned to the United States, where most of its elements were disbanded as part of the general postwar demobilization; the rest were absorbed into what was now known as the 477th Composite Group. In 1946, the Army quietly closed Tuskegee Army Air Field. The influence of the Tuskegee Airmen, however, resonated for generations within the U.S. Air Force and American society in general. The 1948–1949 desegregation of the U.S. military owed much to the success of the 332d Fighter Group and the disgrace of the officers of the 477th Bombardment Group. Former Tuskegee Airmen continued to play important roles in the postwar Air Force, including most notably Benjamin O. Davis Jr., who retired as a three-star general, and Daniel "Chappie" James, who flew more than 60 combat missions during the Vietnam War and became the first African American to achieve four stars.

By the mid-1990s, African Americans represented more than 5 percent of the officer corps and 17 percent of the enlisted personnel in the U.S. Air Force. Recent years have seen an explosion of interest in the Tuskegee Airmen, and in November 1998 President Bill Clinton approved a congressional resolution authorizing the creation of the Tuskegee Airmen National Historic Site at Moton Field in Tuskegee, Alabama.

David Rezelman

See also

Air Superiority; Bell P-39 Airacobra and P-63 Kingcobra; Curtiss P-40 Warhawk; Davis, Benjamin O. Jr.; James, Daniel "Chappie"; Mediterranean Theater of Operations; North African Campaign; North American P-51 Mustang; Republic P-47 Thunderbolt; STRANGLE; U.S. Army Air Forces; World War II Aviation

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Twining, Nathan F. (1897–1983)

U.S. Air Force Chief of Staff; chairman of the Joint Chiefs of Staff at a time when massive nuclear retaliation developed into U.S. national strategy. Oddly, Twining was not being groomed for these weighty positions, as he planned to retire a lieutenant general in charge of the Alaskan command. It is to Twining's great credit that he adapted quickly and with considerable diplomacy to discharge these duties. Crucial among them was the balancing act necessary between the services as the Air Force, especially the Strategic Air Command, which received an increasing share of the budget and operational responsibilities. President Dwight Eisenhower's selection of Twining to chair the Joint Chiefs, effective 15 August 1957, reaffirmed the president's confidence in Twining to assuage interservice rivalries as well as limit defense demands on a budget that Eisenhower wanted to keep small.

Twining was the first Air Force Chief of Staff to visit the Soviet Union, where he attended a military parade intended to demonstrate Soviet military capability. General Twining retired on 30 September 1960.

Robert S. Hopkins

See also

ARC LIGHT; Cold War; Strategic Air Command

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U

Udet, Ernst (1896–1941)

Famous German fighter ace of World War I; chief of Luftwaffe supply and procurement and then head of the Luftwaffe technical office (1939–1941). Udet enlisted in the German army in 1914, learned to fly in 1915, and ended the war as a squadron leader in the fighter wing established by Manfred von Richthofen. His 62 aerial victories were second only to von Richthofen's total and won him the Pour le Mérite. Udet left the service after the Armistice, formed an aviation company, and became well known on both sides of the Atlantic as a stunt pilot and a genial bon vivant. He joined the Luftwaffe in 1935 at the urging of friend Hermann Goering. He was rapidly promoted to full general, but his performance as the head of the technical branch is widely considered to have been disastrous. On 17 November 1941, worn down by the carping of Goering and Milch, Udet put a pistol to his head and killed himself.

Donald Caldwell

See also

German Air Force (Luftwaffe)

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Ugaki, Matome (1890–1945)

Vice admiral in the Imperial Japanese Navy (IJN); a major force behind the attack on Pearl Harbor. Born on 15 February 1890 in Okayama Prefecture, Ugaki graduated from the naval academy in 1912. He served at sea, graduated from the staff college in 1923, and then joined the IJN general staff. He studied in Germany, commanded battleships, and was promoted to rear admiral in 1938.

In August 1941, Ugaki became Chief of Staff of Combined Fleet under Admiral Yamamoto Isoroku. He was involved in planning the Pearl Harbor attack and all other Combined Fleet operations until he and Yamamoto were shot down over Bougainville on 18 April 1943. Ugaki survived, seriously wounded, and returned to Tokyo to recuperate (Yamamoto did not survive).

Ugaki took command of the First Battleship Division on 25 February 1944 and fought at the Battle of the Philippine Sea and through the Leyte campaign.

Ugaki in February 1945 became commander of the Fifth Air Fleet, controlling remaining Japanese naval air forces on Kyushu, the front-line defense of the home islands. Emulating Rear Admiral Takijiro Onishi's example from the Philippines, he formed the Special Attack Corps (Tokkotai) to conduct kamikaze attacks on the U.S. Fleet. The Tokkotai was heavily engaged at Okinawa, using both standard production naval aircraft and specialized rocket-propelled suicide attackers launched from medium bombers.

After Okinawa's capture, Ugaki was engaged in refitting Fifth Air Fleet preparatory to repelling an invasion of Kyushu itself. On 15 August 1945, the Japanese emperor broadcast his decision to surrender. Ugaki, determined to die in the Tokkotai spirit, led an abortive suicide attack on the U.S. Fleet off Okinawa.

Paul E. Fontenoy

See also

Cape Engano, Battle of; Coral Sea, Battle of the; Eastern Solomons, Battle of; Guadalcanal; Japanese Naval Air Force, Imperial; Kamikaze Attacks; Leyte Gulf, battle of; Midway, Battle of; Okinawa; Pearl Harbor; Philippines; Santa Cruz, Battle of; Yamamoto, Isoroku

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Ultra

The term applied to the successful breaking of the German Enigma (and later the Japanese Magic) machine codes during World War II. The German navy began using Enigma in 1926, the German army two years later, and the Luftwaffe only in 1935. The code was partially cracked by Polish intelligence in the 1930s, and work continued at England's Bletchley Park ("Station X"), with an emphasis on breaking German U-boat codes to protect Allied convoys.

In mid-1943, British and U.S. authorities agreed to cooperate on code-breaking activities, with the British concentrating on German and Italian codes, the Americans on Japanese codes. By the end of 1943, Bletchley code-breakers were providing more than 80,000 Enigma decrypts per month. As U.S. officers served as liaisons for U.S. forces, more air force–related intelligence resulted from Bletchley's "Hut 3" facility, considerably aided by poor Luftwaffe communications security. Even by 1943, however, Ultra was but one of many inputs into target selection for USAAF and RAF strategic bombing of Germany, as Enigma was not normally used to communicate industrial activity.

Ultra did provide insight into the impact of such bombing and offered details on Luftwaffe intent, organization, and, by 1944, declining operations. Ultra became the standard used to compare and evaluate other intelligence. Yet even by the end of the war, only 25–30 officers at the Eighth Air Force were cleared for Ultra intelligence along with a mere handful at Ninth Air Force headquarters. This was because security factors were uppermost in applying Ultra knowledge to military actions; thanks to such success, the Germans never learned their codes had been compromised. Enigma/Ultra intelligence remained highly classified until the early 1970s, partially because the British shared captured Enigma machines with other nations for decades after the war and could thus read their codes.

Christopher H. Sterling

See also
Air Technical Intelligence; Magic; Signals Intelligence; U.S. Army Signal Corps; Y-Service

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United Aircraft

U.S. aviation and aerospace corporation from 1934 to 1975; predecessor of the modern-day United Technologies. United Aircraft Corporation (UAC) exemplified the industrial foundation from which airpower is based. The design, development, and construction of sophisticated military aeronautical products required extensive investment in both facilities and personnel and a dependence on government contracts. Centered on a vast industrial complex near Hartford, Connecticut, UAC sustained itself as a primary contractor to the U.S. military for 40 years and provided the engineering and financial leadership that solidified its position in the ever-expanding U.S. military-industrial-research complex.

UAC has its origins in the Pratt and Whitney Company, founded in 1925 by Frederick B. Rentschler and other former Wright Aeronautical Corporation employees. They designed the Wasp radial engine, which was a key technology in the establishment of modern military and commercial aviation in the 1920s and 1930s. Rentschler envisioned the formation of a combine that represented a full-service approach to manufacturing, selling, and transportation within the entire aviation industry. Rentschler and airframe manufacturers William Boeing and Chance Vought organized the United Aircraft and Transport Corporation (UATC) in February 1929. The primary corporate members were Pratt and Whitney, Boeing, Vought, Sikorsky, the Hamilton Standard Propeller Company, and United Air Lines. UATC dominated the manufacturing and transportation segments of the U.S. aviation industry until airmail scandals and accusations of a UATC monopoly led to the division of the corporation in 1934.

The UAC, consisting of Pratt and Whitney, Vought, Sikorsky, and Hamilton Standard, persisted to remain the most successful U.S. aviation manufacturing combine of the 1930s. The corporation was a primary contractor to the U.S. government for airframes, engines, and propellers. During the aggressive world rearmament of the late 1930s, UAC also maintained a vigorous business through the licensing of its products to foreign nations, including France, Germany, Great Britain, and Japan.

During World War II, UAC was a primary military contractor. UAC manufactured an unprecedented quantity of airframes and propulsion systems for trainers, fighters, bombers, and transports. Hamilton Standard–designed propellers constituted more than 75 percent of all propellers used by Allied forces during the war. Pratt and Whitney produced 50 percent of the nation's total aerial horsepower in World War II. UAC achieved this through licensed production, which allowed nonaviation manufacturers to manufacture UAC products for the war effort. Sikorsky-built helicopters were the only U.S. types to see service in World War II.

UAC continued to be a leader in military aerospace technology after the war. The corporation's state-of-the-art research center employed many of the leading aerospace engineers of the twentieth century. Pratt and Whitney oversaw the introduction of the new jet-propulsion technology with the highly successful J-57 turbine, which powered early military turbojet aircraft such as the B-52, KC-135, and F-100. In the late 1950s, UAC began developing missiles, rockets, and spacecraft and acquired Norden, a manufacturer of advanced avionics. Military contracts dominated UAC's production and sales until the early 1970s. When the corporation began to diversify its product base into nonmilitary markets in 1975, UAC changed its name to United Technologies Corporation.

Jeremy R. Kinney

See also

Boeing Company; Civil Aviation, and Impact of Military Advances; Engine Technology; Propellers; Sikorsky, Igor I.; U.S. Aircraft Development and Production (World War I); Vought Aircraft

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United States Air Force: Organizational History

The National Security Act of 1947 established the Department of the Air Force on 18 September 1947. W. Stuart Symington, who had been serving as the assistant secretary of war for air, became the first Secretary of the Air Force, and General Carl A. Spaatz became the first Air Force Chief of Staff. Under law the civilian hierarchy was to have precedence over the military, but Symington considered the military the competent authority in training and readying forces for war. Symington envisioned his role as being the spokesman for the Air Force when pursuing its goals in Congress.

The newly created department authorized the Office of the Secretary of the Air Force, an undersecretary, and two assistant secretaries. More significant was the coequal status gained by the secretary and the USAF Chief of Staff with their counterparts in the Departments of the Army and Navy.

This status was not attained easily. It was the fruition of years of effort by advocates of airpower and a separate air arm. Army aviation activities ran the gamut: U.S. Army Signal Corps balloon observation in the Civil War and Spanish-American War; the foundation of the Signal Corps Aeronautical Division in 1907; the awarding of the first airplane contract (to the Wright brothers) in 1909; the establishment of the Signal Corps Aviation Section in 1914; and the valiant efforts of the 1st Aero Squadron during the Punitive Expedition against Pancho Villa in Mexico in 1916 and 1917.

On the eve of U.S. entry into World War I, the Army's air arm found itself ill-equipped and ill-prepared. It also failed to achieve its expansion goals by the spring of 1918. A reorganization seemed essential, and on 20 May 1918 President Woodrow Wilson ordered the War Department to establish the Air Service. This entity consisted of two agencies: one under a civilian head to deal with the manufacturers; the other under a military officer for training and organizing units. This structure was further streamlined in August 1918 when President Wilson appointed John D. Ryan as an aviation czar to strengthen the system.

The U.S. Army Air Service did enjoy some success in its brief World War I experience. With Major General Mason Patrick organizing the Air Service and Brigadier General William "Billy" Mitchell in charge of air combat, the air arm found immediate work flying reconnaissance missions, which proved valuable in locating enemy troop formations supporting U.S. ground forces. In air-to-air encounters, U.S. pilots made a good showing, with 71 American aces (those achieving five or more kills). Captain Eddie Rickenbacker led the way with 26 victories. During seven months of combat, U.S. air forces launched some 150 bombing missions and claimed 756 enemy aircraft and 76 balloons destroyed, losing 289 aircraft, 48 balloons, and 237 crewmen.

The achievements of World War I helped nurture a movement to establish an independent air force. But the U.S. Army's leaders viewed the airplane primarily as a support weapon for the infantry and relegated the Air Service to a status similar to the field artillery and engineers. In addition, between 1920 and 1926 attempts to legislate needed changes in the nation's air defense were blocked by a jurisdictional conflict with the Air Service on one side and the War Department and the Navy on the other.

During this period a series of boards and commissions studied and restudied the air organization issue, culminating in the Army Air Corps Act of 1926. Although the act did not grant independence or autonomy, it did establish the Army Air Corps, granting it more personnel, aircraft, and prestige than its predecessor. The act also called for Air Corps representation on the Army General Staff and reestablished a second assistant secretary (assistant secretary of war for air). F. Trubee Davison was the first to hold this position; he remained until 1932, when he ran for lieutenant governor of New York.

Despite opposition to a separate service and a paucity of funding (felt by all the services), the Air Corps managed significant achievements during the interwar period. In concert with record-breaking flights in speed, distance, and endurance accomplished by civilian and military fliers alike, an Air Corps doctrine of precision bombing of industrial targets by heavily armed long-range bombers began to emerge in the Air Corps Tactical School.

A major reorganization in March 1935 established the General Headquarters Air Force, which allowed the Air Corps to achieve unified command over its combat units. This command, headed by Brigadier General Frank M. Andrews, a bomber enthusiast and advocate of an independent air force, succeeded in removing combat air units from the control of local commanders by obtaining jurisdiction over all questions relating to the organization of units, maintenance of aircraft, as well as operation of technical equipment, maneuvers, and training.

Despite efforts by the Army General Staff to obtain larger appropriations for the air arm during the mid-1930s, the aircraft inventory in the Air Corps fell in 1936; Congress authorized it to purchase only a few of the new four-engine B-17s specifically designed for strategic bombing. As late as 1938, only 13 B-17s were in the inventory.

With the onset of World War II, the fortunes of airpower and its advocates changed as accounts from Europe in 1939 and 1940 presaged the dominant role of the airplane in war. On 20 June 1941, a further reorganization occurred when Major general Henry H. "Hap" Arnold, chief of the Air Corps, became chief of the Army Air Forces and assumed command of the Air Force Combat Command (as General Headquarters Air Force had been renamed). Less than a year later, in March 1942, Arnold became commanding general, AAF, which made him coequal with the commanders of the Army ground forces and services of supply. Arnold now reported directly to the Chief of Staff of the Army, General George C. Marshall, and both agreed that the AAF would have full autonomy within the War Department but that any move toward an independent Air Force would be postponed until the end of the war.

In the meantime, the civilian side of the Air Corps boosted its cause with the April 1941 appointment of Robert A. Lovett to assistant secretary of war for air, which had been vacant since Davison's departure. Lovett, an investment banker who had served in the naval Air Service during World War I, had retained a keen interest in aviation throughout the interwar years. Although not actually granted statutory power to direct procurement, Lovett was encouraged by Secretary of War Henry L. Stimson to promote aircraft production. While advising Stimson, Lovett worked closely with military leaders and was free to voice opinions on a variety of questions outside the formal chain of command.

From April 1940 until the end of World War II, Lovett was concerned that nothing should threaten industry's adherence to realistic aircraft production schedules. He attempted to settle labor disputes and at times intervened when the Office of Production Management and, subsequently, the War Production Board were at odds with AAF contractors, subcontractors, and suppliers. During the war, Lovett acted as a sounding board for industry complaints and requests. Henry L. Stimson had a clear conception of Lovett's role, telling him, "Whatever authority the Secretary of War has, you have."

Lovett and Arnold formed a partnership in fashioning the AAF into the world's most powerful air force. Indeed, beginning with 20,000 men and 2,400 aircraft in 1939, by war's end the AAF comprised 2.4 million personnel, and U.S. industry produced almost 160,000 aircraft, including the B-17 Flying Fortress, B-24 Liberator, and B-29 Superfortress—the workhorses of the European and the Pacific theaters; the P-47 Thunderbolt and the P-51 Mustang fighters; and the C-47 Skytrain transport. The tremendous increase in size necessitated a reorganization that replaced Air Force Combat Command with four air forces in the continental United States. This force was subsequently complemented with 12 additional overseas air forces.

After the war, the AAF and its newly appointed assistant secretary of war for air, Stuart Symington, worked toward independence. As the AAF demobilized, Symington sought to instill cost-control measures to coincide with an austerity-minded Congress and the public. He believed the AAF "had an unusual opportunity to look toward efficiency, no past heritages, no barnacled procedures to first overcome." He and General Carl A. Spaatz, the new AAF Chief of Staff, worked toward the goal of a 70-group postwar Air Force.

Independence was finally realized with the passage of the National Security Act in July 1947. The Air Force had previously created three major combat commands in the United States: Strategic Air Command, Tactical Air Command, and Air Defense Command. SAC, under Commanding General Curtis E. LeMay (1948–1957), became the dominant Air Force command. Even though the Military Air Transport

Service played the key role in airlifting supplies during the Berlin Airlift and tactical air forces were built up during the Korean War, SAC maintained first call on USAF resources. Leaving office in April 1950, Symington was disappointed at not attaining a 70-group Air Force. However, the Korean War provided a spurt in funding for a larger air force, new weapons systems, and more personnel, permitting Air Force Secretary Harold E. Talbott (1953–1955) to concentrate on other important issues such as military housing.

During the 1950s, three pieces of legislation diminished the authority of the secretary of the Air Force. The 1949 amendments gave more power to the secretary of defense by granting him an undersecretary and three assistant secretaries. The secretary of the Air Force, along with the other service secretaries, lost their seats on the National Security Council, where they had been coequal with the secretary of defense. The 1953 Reorganization Act further eroded the power of the service secretaries by adding six more assistant secretaries to Defense. Next, the 1958 Reorganization Act took the service secretaries out of the direct chain of operation (combat) command, which now ran from the president and secretary of defense through the Joint Chiefs of Staff to the unified and specified commands, making the service secretaries responsible for operations support such as training and logistics. Secretary of Defense Robert S. McNamara, appointed by President John F. Kennedy, took full advantage of the powers granted by this legislation.

In addition to the huge Korean War buildup of a 95-wing air force under the leadership of Air Force Secretary Thomas K. Finletter and Chief of Staff Hoyt S. Vandenberg, the 1950s also witnessed the advent of missile technology. The missile program was advocated by Trevor Gardner, an Air Force special assistant for research and development, and implemented by Brigadier General Bernard A. Schriever. Schriever founded the Space and Ballistic Missiles Organization and later became commander of Air Force Systems Command. Under Schriever, the Air Force developed the Atlas, Titan, and Minuteman long-range missiles and established the basis for the Air Force space program.

The retrenchment in personnel and equipment following the Korean War buildup was somewhat alleviated by the technological advancements in both missiles and satellites in response to advances by the Soviet Union, the country's Cold War nemesis. In 1957, spurred by the shock of Sputnik and fears of a missile gap, SAC began the process of complementing its bomber fleet with land-based missiles. By the end of the 1960s, more than 1,000 ICBMs were on alert as bomber numbers dwindled. Thus, the air force possessed two key legs—strategic bombers and land-based missiles—of the important "Triad" (the Navy fielded the third leg: submarine-launched ballistic missiles). In the meantime, TAC benefited from the Kennedy administration's emphasis on conventional forces that could respond to several protracted conventional conflicts under the sheltering nuclear umbrella.

In Southeast Asia, U.S. strategy was to hold off North Vietnam until South Vietnam became a viable nation able to defend itself. During the Vietnam War (1965–1973), the United States dropped three times the number of bombs that it did during World War II. During Operation ROLLING THUNDER (March 1965–October 1968), the air campaign against North Vietnam, the Air Force faced a formidable air defense system. Hampering its efforts were restrictive rules of engagement such as a 30-mile restricted area around Hanoi. ROLLING THUNDER caused about $2 billion in losses to the North Vietnamese economy at the expense of perhaps $2 billion in U.S. aircraft, but it failed in its purpose to thwart the communist efforts in the South.

Supplying and transporting troops was a major Air Force mission. This charge, as well as ensuring that service personnel were properly equipped, trained, and deployed, became, according to Air Force Secretary Eugene M. Zuckert, the role of the secretariat. Secretary of Defense McNamara took advantage of the legislation of the previous decade that had dampened the powers of the service secretaries to assert the centralized authority of his office. This was particularly troubling for Zuckert, who had witnessed the previous power of the secretariat as Symington's assistant secretary and also for the man who had constructed SAC, General Curtis E. LeMay. The Air Force Chief of Staff, who remained ultimately responsible for the day-to-day activities of the organization, also served on the Joint Chiefs of Staff. Thus, Air Force C-47 Skytrains, C-119 Boxcars, C-123 Providers, and C-130 Hercules maneuvered vast supplies about the jungle terrain while C-141 Starlifters and C-5 Galaxies, assisted by commercial airlines, moved troops and supplies from the United States to Vietnam. SAC B-52 bombers and tactical forces assisted the U.S. and South Vietnamese armies in South Vietnam and struck at North Vietnamese Army supply lines along the Ho Chi Minh Trail and in southern Laos, where their air strikes supported counterinsurgency efforts of the Laotian government. In addition, operations over Cambodia were designed to support the war in South Vietnam.

After the war, the Air Force had to adjust to tighter budgets and simultaneously build its strategic forces and maintain readiness in Europe, a theater that had been neglected during the conflict in Southeast Asia. In 1970, Secretary of Defense Melvin Laird popularized the term "Total Force" to describe the relationship between the active duty and reserve components.

John L. McLucas became Air Force secretary as the Vietnam War ended; he viewed his role as repairing the wreckage caused by equipment losses and dampened morale. He, along with his Chiefs of Staff, General George S. Brown and then General David C. Jones, sought to concentrate on newer weapons systems such as the B-1, F-15, and F-16 while in some cases selecting from rival prototypes to avoid the blunders experienced with the C-5A and FB-111 during the previous decade. In light of dwindling monies, General Jones professed a policy of "readiness," meaning streamlining headquarters organization and pursuing the development of high-tech weapons. Budgetary restraints had an effect throughout the force as training and flying-hour retrenchments led some to label the middle to late 1970s as the era of the "Hollow Force."

After taking office in January 1981, President Ronald Reagan announced an extensive effort to modernize the Air Force's strategic forces. The B-1B program, canceled in 1977, was revitalized, and the bomber reached initial operational capability in September 1986. The Air Force modified its B-52G and H models to carry air-launched cruise missiles, and it modernized its ICBM force by deploying Peacekeeper (formerly MX) missiles in Minuteman silos. Two stealth aircraft flew for the first time during the decade: the F-117A fighter-bomber (flying in June 1981) and the B-2A strategic bomber (1989).

The Reagan administration also devoted considerable attention to space. Air Force Space Command was activated on 1 September 1982, and the following March, Reagan introduced the Strategic Defense Initiative (SDI, or "Star Wars"), a wide-ranging effort to investigate technologies that could contribute to a missile shield. The Air Force transferred its SDI efforts to the Strategic Defense Initiative organization in 1994. Today it is more commonly known as Ballistic Missile Defense.

From the early to mid-1980s, Air Force budgets enjoyed five years of unprecedented double-digit growth, enabling Air Force Secretary Verne Orr (1981–1985) to concentrate on people-oriented issues such as housing and the advancement of women. The 1980s also witnessed a trend toward jointness among the services that was spurred by the Goldwater-Nichols Act. Both of Orr's chiefs of staff, General Charles A. Gabriel and then General Larry D. Welch, supported this effort even though this act reduced their power as well as that of the other service chiefs in favor of the chairman of the Joint Chiefs. Earlier, on 22 May 1984, General Gabriel and his Army counterpart, General John A. Wickham Jr., had signed a landmark agreement on 31 joint initiatives that the Army and Air Force had identified as essential to supporting affordable and effective air-land combat forces.

When Iraq invaded Kuwait in August 1990, President George Bush mobilized an international coalition and ordered U.S. military units to execute Operation DESERT SHIELD, an enormous deployment of forces to defend Saudi Arabia. Within six weeks Air Force cargo aircraft bought more tonnage (in terms of ton mileage) to Southwest Asia than they had carried during the entire 15-month Berlin Airlift. The DESERT SHIELD air transporters eventually moved 500,000 passengers and nearly 500,000 tons of dry cargo a third of the way around the world in about seven months.

On 17 January 1991 local time, the United States and its allies began Operation DESERT STORM to liberate Kuwait. The Gulf War that followed was remarkable for it brevity, relatively low Coalition casualties, and decisive results. The Air Force component of United States Central Command, United States Central Air Forces (CENTAF), provided the centerpiece of victory. The war lasted only 43 days, 39 of them devoted to a stunningly successful Coalition air campaign against targets throughout Iraq and the Kuwaiti Theater of Operations (southern Iraq and Kuwait). CENTAF aircraft destroyed Iraq's air defenses, crippled its electrical-source infrastructure, and leveled many of its nuclear, biological, and chemical warfare facilities. Coalition air attacks against Iraqi forces made possible the rapid success of the ground campaign that followed.

With the end of the Cold War, the Air Force entered another era of austerity: fiscal year 1992 and 1994 budgets showed -10.0 and -8.5 percentages of real decline. With a reduced force structure as well as a blurring of the distinction between strategic and tactical missions—which had been evident during the Gulf War—Air Force Undersecretary Donald Rice and Chief of Staff General Merrill McPeak began to reorganize several major commands. On 1 June 1992, the Air Force activated Air Combat Command, which combined all of Tactical Air Command assets with most of Strategic Air Command and a small portion of Military Airlift Command (MAC). On the same day, Air Mobility Command, which blended most of MAC's force structure with SAC's tankers, came into existence. Finally, Air Force Materiel Command, combining the resources of Air Force Systems Command and Air Force Logistics Command, was activated a month later. Although downsizing and retrenchment was part of the reorganization, the USAF adopted the expansive slogan "Global Reach—Global Power" and considered its future role as the guarantor of world stability.

Meanwhile, General McPeak responded to the downsizing mandated by Congress and the Clinton administration by setting out to reorganize the Air Force. In addition to major command restructuring, he experimented with different wing-level organization concepts, including the composite wing and the objective wing. McPeak stressed the heritage of the Air Force in determining which units would be retained and which ones would be cut.

McPeak's successors, Generals Roland R. Fogleman and Michael E. Ryan, fine-tuned this process: Fogleman supported a "Global Engagement" long-range plan and a "core values campaign"; General Ryan encouraged establishment of an Aerospace Expeditionary Force (AEF) capable of rapid deployment and ready to meet any global challenge. Ryan saw 10 AEFs each deployed for 90 days every 15 months with two AEFs on call at all times. Congress did not provide the sustained funding that his plan required, and at the turn of the century the Air Force was definitely a smaller force. Yet Congress—the engine for change—seemed to agree that the Air Force had been sufficiently downsized.

The beginning of the U.S. war on terrorism in the fall of 2001 changed the entire equation. The USAF was thrust into the front lines of an air campaign against an entrenched enemy in Afghanistan. The action carried significant implications for future military budgets and priorities.

George M. Watson Jr.

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United States Air Forces in Europe (USAFE)

United States Air Forces in Europe has its origins in the Eighth Air Force from World War II. Established as the Eighth Air Force on 19 January 1942, activated on 28 January 1942, and designated Eighth Air Force on 18 September 1942; designated United States Strategic Air Forces in Europe on 22 February 1944. These organizations were responsible for planning and executing the U.S. strategic bombing plan against Nazi Germany from England as well as bases in the Mediterranean.

On 7 August 1945, the organization was designated United States Air Forces in Europe. Between 22 January 1951 and 1 July 1956, USAFE was identified as a specified command by the Joint Chiefs of Staff. USAFE was headquartered at Lindsey Air Station, Weisbaden, West Germany, until March 1973, when it moved to Ramstein AB, West Germany. USAFE headquarters is colocated with NATO's Allied Air Forces Central Europe (AIRCENT). The USAFE commander commanded both USAFE and AIRCENT.

The Berlin Airlift was the first real test of USAFE. Major General Curtis E. LeMay, USAFE commander, directed Major General William H. Tunner to establish an air bridge into Berlin. Subsequently, General Tunner developed and implemented the Air Logistics Service to provide scheduled deliveries of critical materiel throughout the European and Mediterranean areas.

With the formation of NATO, USAFE took on an even greater role in showing Western resolve against the ever-growing communist threat in the region. By the end of 1951, USAFE's responsibilities had expanded in Europe and eventually extended to French Morocco, Greece, Italy, Libya, Spain, Saudi Arabia, and Turkey. When Spain withdrew from NATO in 1967, all foreign troops were directed to leave their nation, resulting in a major restructuring of NATO.

When the Soviets began deploying mobile tactical nuclear weapons into Warsaw Pact nations adjacent to Western Europe, President Ronald Reagan called for a showdown. The USAF deployed ground-launched intermediate-range missiles to USAFE bases. This threat resulted in the Intermediate Range Nuclear Forces Treaty, ratified in 1988, that mandated the first-ever elimination of an entire class of weapons from U.S. and Soviet inventories. The Soviet missiles were withdrawn from their forward locations and dismantled, as were the U.S. weapons. By March 1991, the last of these missles were removed from Comiso Air Station, Italy.

During Operation DESERT SHIELD and Operation DESERT STORM, USAFE deployed more than 180 aircraft and 5,400 personnel; 100 aircraft and 2,600 personnel were deployed for Operation PROVEN PEACE staging out of Turkey. The command also established numerous aeromedical staging facilities in the event they were needed for combat in the Gulf region.

The Third Air Force, based in England, served as host for Strategic Air Command rotational forces during the 1950s through the 1980s. The Sixteenth Air Force, originally a SAC unit, was established at Torrejon AB, Spain, to support SAC operations in the region between 1956 and 1966.

During the Vietnam War, USAFE hosted Air National Guard (ANG) tanker units deploying to Europe to fulfill America's aerial refueling commitments for NATO while SAC tankers fought in the war. These ANG deployments were flown under Operation CREEK PARTY.

With the end of the Cold War, USAFE lost 67 percent of its operational bases; however, the organization continues to serve as a staging site for contingency operations and humanitarian relief missions throughout the region. Currently, USAFE controls two numbered air forces (Third Air Force at RAF Mildenhall, England; and Sixteenth Air Force, at Aviano). USAFE's main operating bases are RAF Lakenheath and RAF Mildenhall in England, Ramstein and Spangdahlem Air Bases in Germany, Aviano Air Base, Italy, and Incirlik Air Base, Turkey.

Alwyn T. Lloyd

See also

Air National Guard; DESERT SHIELD; DESERT STORM; LeMay, Curtis E.; North Atlantic Treaty Organization; STRATEGIC AIR COMMAND; Tunner, William H.

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United States Army Air Corps (USAAC)

Early aviation branch (1926–1941) of the U.S. Army. The U.S. Army Air Corps was established on 2 July 1926, as the Air Service had fallen into neglect during the years following World War I. By the mid-1920s, the Air Service had dwindled to the point of near nonexistence. Underfunded, undermanned, and underequipped, it had less than 1,000 officers and possessed only 60 pursuit and 169 observation aircraft. Most significantly, the Air Service had few bombers.

Because of the obvious need to improve and expand the air arm, President Calvin Coolidge in September 1925 appointed a board, headed by Dwight W. Morrow, to come up with a more efficient way to employ aircraft in the national defense. Although a congressional committee (the so-called Lampert Committee) had already proposed a unified air force independent of the Army and Navy, the report issued by the Morrow Board rejected that idea. Instead, it recommended that the Air Service be more prestigiously named and given representation on the U.S. Army General Staff. In addition, an assistant secretary of war for air affairs was to be appointed. The resulting Air Corps Act of 1926 officially put these recommendations into effect, creating the U.S. Army Air Corps.

Over the next few years, the sad state of the Air Corps improved somewhat, although the Depression significantly

The Boeing P-26 "Peashooter" was a transitional aircraft. The all-metal monoplane retained the open cockpit and fixed gear of its biplane predecessors. (U.S. Air Force) slowed the planned expansion program. By 1931, a long-proposed flight center in San Antonio had been established, with the Air Corps Training Center located at the newly commissioned "West Point of the Air"—Randolph Field. A materiel division was also established at Wright Field, Dayton, Ohio, where technical and logistical experts began to set the stage for the future greatness of U.S. airpower. Other subordinate Air Corps agencies included technical, balloon/airship, and tactical schools. By 1939, the Air Corps roster had increased to 23,455 men and by 1941 to 150,000.

In terms of technical accomplishments, the USAAC also saw significant progress during the late 1920s and throughout the 1930s. Although the numbers of aircraft increased only nominally to 2,177 by 1939, numerous revolutionary advances were made. Aircraft engines improved in power-to-weight ratios, and wood-and-fabric open-cockpit biplanes gave way to sleek all-metal enclosed monoplanes. Other significant improvements included the variable-pitch propeller and retractable landing gear, as well as much-improved all-weather and nighttime navigational instrumentation. These changes collectively resulted in increased speeds, altitudes, and endurance, as well as greater load-carrying, bombing, and defensive capabilities.

With increased aircraft performance came an opportunity to demonstrate growing missions capability. Several record-setting flights were accomplished, including the 2,418-mile nonstop flight of the *Bird of Paradise* by Lester Maitland and Albert Hegenberger from California to Hawaii in 1927, the 151-hour endurance flight of the *Question Mark* by Carl Spaatz, Ira Eaker, and Elwood Quesada in 1929, and the 8,290-mile round-trip by a B-10 bomber formation flight from Washington, D.C., to Alaska and back, led by Lieutenant Colonel Henry "Hap" Arnold in 1934.

Even with such striking successes and technical improvements, the USAAC continued to lag behind many other countries—some of which were already preparing for the next world war—in airpower capability. This inadequacy was tragically emphasized by the airmail fiasco of 1934. When U.S. Postmaster James Farley cancelled government airmail contracts with commercial carriers in February of that year, the Air Corps was tasked to take over the overwhelming job of delivering the mail. USAAC pilots gamely took on the assigned mission without proper aircraft, equipment, training, experience, and organizational skills. By the time USAAC mail flights ended three months later, 12 Army fliers had been killed in 66 accidents, driving home the inadequacies of the Air Corps in the eyes of the American public. If there was a positive consequence, it was that Congress allocated funds for much-needed upgrades in Air Corps equipment and training.

Another important development of the mid-1930s was the creation—on the recommendation of a board chaired by a former secretary of war, Newton Baker—of the General Headquarters Air Force (GHQ AF) on 1 March 1936. The GHQ AF was made up of air combat units capable of operating independently or in cooperation with ground forces. Although it was viewed by some as a step toward an independent air mission and organization, it still kept the air arm under Army command—a sore point for many Air Corps leaders.

In the late 1930s, the most significant USAAC efforts centered around developing into a large, modern air force with global capabilities. Only this would ensure an airpower mission independent of surface forces. These efforts were boosted by the development of the new Boeing B-17 "Flying Fortress" heavy bomber. This revolutionary aircraft—destined to become the dominant symbol of American airpower—was heavily funded during this period, unavoidably at the expense of fighter development.

Unfortunately, some opposition was encountered by the U.S. Army General Staff, desperately in need of funds; consequently, critical funding for the mighty B-17, as well as other needed aircraft, was withheld until the rearmament process began just prior to World War II. Finally, in 1939 Congress authorized $300 million for the Air Corps to more than triple its existing paltry inventory of aircraft up to a total of 5,500; by 1940 this number was increased to almost 13,000. Likewise, pilot-training requirements were eventually increased a hundred-fold over previous levels.

As the USAAF rapidly expanded in the months leading up to World War II, its importance to national defense was realized. In November 1940, General Hap Arnold took on the dual role of acting deputy Chief of Staff for air, as well as chief of USAAC. By early 1941, U.S. Army Chief of Staff George Marshall wisely decided that the air arm needed more unity and authority, so he forcefully pushed forward a general reorganization. Army Regulation 95-5, issued on 20 June 1941, joined the USAAC with the newly named Air Force Combat Command (formerly GHQ AF) and other units to form the U.S. Army Air Forces. Although the Air Corps technically existed until the National Security Act of 1947, which established the U.S. Air Force, it was effectively superseded by the USAAF in 1941. The U.S. Army Air Corps had, however, over the preceding 15 years taken the air arm from near extinction to what would soon become the most formidable air force ever known.

Steven A. Ruffin

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United States Army Air Forces

The World War II–era American air forces (1941–1947); replaced by the independent U.S. Air Force in 1947.

On 1 August 1907, the U.S. Army tackled the issue of airpower in military operations by assigning the Signal Corps oversight of ballooning, air machines, and all kindred subjects. At the time, the Signal Corps Aviation Section boasted four members; it took two years to receive its first aircraft. In March 1913, Signal Corps created the first air squadron in Texas City, Texas. The commander of that squadron was Major Benjamin Foulois; the squadron flew 540 courier and reconnaissance missions.

Shortly after the United States entered World War I in April 1917, President Woodrow Wilson signed the Aviation Act, which apportioned more money to military aviation. In August 1918, President Wilson created the U.S. Army Air Service. The Army Reorganization Act of 1920 made the Air Service a combatant arm of the Army.

The Air Corps Act of 1926 changed the Air Service to the U.S. Army Air Corps. On 1 March 1935, General Headquarters Air Force assumed command of U.S.-based Air Corps tactical units that previously existed under regional Army Corps commanders. As Germany, Japan, and Italy began to build up their armed forces, the Air Corps and the rest of the Army remained a small peacetime organization with little money for expansion or upgrades. After Adolf Hitler launched World War II by invading Poland, the Air Corps began to grow steadily, swelling from 21,000 to 354,000 members, with similar growth in the number of bases, units, and aircraft.

On 20 June 1941, the Department of War created the United States Army Air Forces. Field Manual 100-20 (*Command and Employment of Air Power,* 1943), proclaimed land and airpower were coequal and interdependent, with neither an auxiliary of the other, thereby creating a de facto air force.

By 1944, 16 numbered air forces had taken form, the first four protecting the eastern and western continental United States. In December 1941, the Philippine Department Air Force, which survived the Japanese attack on The Philippines, became Fifth Air Force, headquartered in Australia. In February 1942, Sixth Air Force was formed to defend the Panama Canal and for antisubmarine warfare. The Hawaiian Air Force became Seventh Air Force in February 1942. Also in February 1942, Eighth Air Force went to England to fly bombing raids with RAF Bomber Command. In September 1942, the new Ninth Air Force moved to Egypt. Tenth Air Force was formed in Ohio before moving in March 1942 to operate in the China-Burma-India Theater. Later, the China Air Task Force (including Claire Chennault's "Flying Tigers"), which led guerrilla-style air raids against the Japanese and later flew missions over the Himalayan Hump was designated Fourteenth Air Force. The Eleventh Air Force was formed from the Alaskan Air Force to protect the United States and Canada and to recover the Aleutian Islands from the Japanese. The Twelfth Air Force stood up in August 1942 and moved to England to participate in the invasion of North Africa. In December 1942, Thirteenth Air Force began operating out of several Pacific locations such as the Solomon Islands, New Guinea, the Philippines, the Marianas, Midway, the Caroline Islands, Iwo Jima, Japan, and the Marshall Islands. Fourteenth Air Force served mainly in China after it stood up in March 1943. Fifteenth Air Force activated in Tunisia on 1 November 1943 and began combat operations the next day. Twentieth Air Force, formed by General Henry H. "Hap" Arnold, answered directly to the Joint Chiefs of Staff. Composed of B-29 strategic bombers, its goal was breaking the Japanese Empire and setting the course for a postwar Air Force. The Twentieth changed the course of modern warfare when two of its B-29s dropped the first atomic bombs on Hiroshima and Nagasaki.

World War II was the defining moment for airpower, with its importance growing as theater commanders incorporated it into their operations. Airpower changed the way war was fought, and that power was wielded by the United States Army Air Forces. The Army Air Corps began the war with more than 2,000 members and a few hundred planes. Five years later, the Army Air Forces had nearly 2.4 million airmen and almost 80,000 aircraft. It remains the largest air force ever assembled.

Based on USAAF success in World War II, as well as the possibilities for its future, President Harry S. Truman signed the National Security Act of 1947. The historic legislation created the National Military Establishment—it would later become the Department of Defense—with three executive departments—the Army, Navy, and Air Force. Truman signed the Act while flying on his presidential airplane—*Sacred Cow*—which was operated by the USAAF.

Diane Truluck

See also
Foulois, Benjamin D.

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United States Army Air Service

Early designation for the American air forces (1918–1926). Until the spring of 1918, the U.S. Army Signal Corps retained control of military aviation. This relationship had evolved because of the Signal Corps's interest in combining observation balloons with the telegraph to provide intelligence. The growth of aviation caused a series of reorganizations within the Signal Corps: the Aeronautical Division (1907) and the Aviation Section (1914). Shortly after the U.S. Congress declared war in 1917, it passed an unprecedented appropriation bill of $64 million to build a mighty air force. President Woodrow Wilson separated aviation from the Signal Corps to solve coordination problems by creating the Bureau of Military Aeronautics in May 1918, but this agency did not control aircraft procurement. Consequently, in August 1918 Wilson appointed a civilian director of air service to coordinate both functions. After the war, a major general replaced the civilian director.

During the early postwar period, Brigadier General William "Billy" Mitchell crusaded for a separate and unified air force. He did not achieve his goal, but a greater degree of autonomy was achieved with the creation of the U.S. Air Corps by act of Congress in 1926.

Bert Frandsen

See also
Mitchell, William; U.S. Army Air Corps
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United States Army Signal Corps

Created by Congress in 1860, the Signal Corps had responsibility for all signal duty, and all books, papers and apparatus connected therewith. Under this broad mandate, the Signal Corps expanded its communications methods to include employing captive balloons as portable observation platforms. With the invention of the airplane, heavier-than-air operations also became part of the Corps's mission.

In 1907, the chief signal officer established the Aeronautical Division and issued specifications soliciting bids for a flying machine. Only the Wright brothers delivered a plane, which the Army purchased in 1909. Funding and personnel shortages hampered the Signal Corps's aeronautical efforts. Flight-training initially took place at College Park, Maryland. There the Army's earliest pilots, among them Lieutenants Frank P. Lahm, Benjamin D. Foulois, and Henry "Hap" Arnold, earned their wings. By 1913, the Signal Corps had abandoned balloon operations, and the formation of the 1st Aero Squadron received official sanction.

In July 1914, Congress established the Signal Corps Aviation Section, headed by Lieutenant Colonel Samuel Reber. The 1916 Punitive Expedition into Mexico provided aviation's first real test. General John J. Pershing expected planes to find Pancho Villa and direct troops to capture him. But the 1st Aero Squadron's fragile underpowered machines could not cope with the high altitudes and strong winds of the Mexican mountains. Although they did not find Villa, the pilots performed reconnaissance, delivered messages, and took aerial photographs.

World War I proved to be the first air war. European nations, however, possessed air forces that far surpassed the U.S. force. By placing aviation within the Signal Corps, the Army had focused on aviation's reconnaissance function rather than its combat potential. Consequently, the Army had no combat aircraft and the nation had virtually no aviation industry in April 1917. Military and government leaders mistakenly assumed that the automotive industry could quickly convert to aircraft production. Meanwhile, General John Pershing, who did not believe that aviation should be part of the Signal Corps, created the separate Air Service within the American Expeditionary Forces. Although this arrangement worked well overseas, it complicated matters at home. Promises of production went unfulfilled, and U.S. pilots remained dependent on European airframes. The one bright spot was the development of the Liberty engine.

Decentralized control and lack of clear direction proved fatal to the Signal Corps's aviation program. The Corps and its wartime chief, Major General George O. Squier, received considerable criticism and scrutiny. After several investigations, President Woodrow Wilson removed aviation from the Signal Corps in May 1918 and placed it under the secretary of war's direct control. The Signal Corps retained responsibility only for airborne radio.

Under its communications umbrella, the Signal Corps fostered the development of military aviation within the United States. But as aviation's combat role became predominant, the break from its parent Signal Corps became inevitable. Separation was the first step toward the establishment of the independent Air Force in 1947.

Rebecca Robbins Raines

See also

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United States Navy

Naval aviation officially began on 8 May 1911 when Captain Washington Irving Chambers submitted a requisition for two aircraft to be built by Glenn Curtiss.

Before that, on 14 November 1910, Eugene Ely, a civilian pilot, took off in a 50-hp Curtiss plane from a wooden platform built over the bow of the light cruiser USS *Birmingham* anchored in Hampton Roads, Virginia. On 18 January 1911, Ely, flying a Curtiss pusher, landed on a specially built platform aboard the armored cruiser USS *Pennsylvania* at anchor in San Francisco Bay.

In July 1919, the Naval Appropriations Act provided for the conversion of the collier *Jupiter* into a ship specifically designed to launch and recover airplanes at sea. It was commissioned as the USS *Langley,* the nation's first aircraft carrier. The engineering plans for this conversion were modified in November 1919 and included catapults to be fitted on both the forward and aft ends of the deck. The USS *Range*r was the first ship of the U.S. Navy to be designed and built as an aircraft carrier; the ship was commissioned on 4 June 1934.

In addition, during the late 1920s and early 1930s the Navy introduced a rigid airship program. The Navy saw these as long-range scouts and launch platforms for Sparrowhawk fighters. The program never got up to speed because of two devastating crashes. The *Akron* crashed on 3 April 1933, killing 73 men, including Admiral William Moffett, a strong supporter of the program. The second crash, the *Macon* on 12 February 1935, took four Sparrowhawk

Boeing fighters had a pugnacious look, as exemplified by this F4B-2. (U.S. Navy) fighters down with it; all but two of the crew survived the crash.

The development of aircraft carriers and carrier operations sparked a revolution in military affairs, completely and irrevocably changing the prosecution of war at sea. But that would not occur until 1941.

On 7 December 1941, carrier aircraft of the Japanese Imperial Navy launched a devastating attack on Pearl Harbor and the military and air installations in the area. The three aircraft carriers of the Pacific Fleet were at sea and were spared attack. With this attack, the face and philosophy of naval aviation changed forever. The great dueling battles between battleships became obsolete virtually overnight. Dramatic and historic events would follow.

In April 1942, the USS *Hornet* launched 16 B-25 bombers in an attack against the Japanese mainland led by Lieutenant Colonel James Doolittle. The famous Doolittle Raid lifted sagging American morale and shocked the Japanese. In May 1942, the Battle of the Coral Sea saw the first large-scale battle involving naval aircraft. In June 1942, at the Battle of Midway, the Japanese navy lost four carriers, one cruiser, 250 aircraft, and 3,500 personnel, most to naval aviation. The United States lost one carrier (*Yorktown*), 132 aircraft, and 300 men. Most historians say Midway marked the turning point of the Pacific War. At the Battle of the Mariana Islands, the Japanese lost two carriers and about 300 aircraft to U.S. Navy and Marine pilots.

Naval aviation was also an integral part of the island-hopping campaign waged by U.S. ground forces. Whether preceding or during a battle, Navy aircraft supported the ground forces with bombing and strafing runs.

On 3 October 1942, the Navy took delivery of the first production models of the F4U Corsair. Over the course of the next 10 years, until the last one rolled off the Chance-Vought assembly line in Dallas in December 1952, the aircraft would live up to its nickname—"Swift Ship"—although its domain was the clouds rather than the sea. During World War II, Corsair pilots downed 2,140 Japanese aircraft, achieving an 11:1 kill ratio.

The atomic age arrived over Hiroshima and Nagasaki in August 1945. USAAF generals attempted to diminish the Navy's role in aviation by declaring long-range bombers equipped with atomic weapons had made conventional forces obsolete. The National Security Act, signed by President Harry S. Truman on 18 July 1947, furthered the bomber barons' clout by creating the independent U.S. Air Force.

In postwar America, the military services engaged in debates over their respective roles and missions. By far the bitterest pitted the Navy against the Air Force. The Navy believed that the atomic mission could be carried out partially from the decks of carriers and managed to obtain funding for a 1,090-foot flush-deck supercarrier to be called USS *United States.* The Air Force argued that money for the ship would be better spent on a fleet of giant B-36 bombers.

The years following World War II also marked a time of transition for naval aviation. With dwindling defense budgets and bitter interservice rivalry, the very existence of sea-based airpower was questioned. Strategic bombing employing the atomic bomb had supplanted the Navy as the nation's first line of defense and minimized the importance of tactical aviation. The severity of the situation was such that by mid-1950 a carrier fleet that numbered 98 at the end of World War II had been reduced to 15.

The so-called revolt of the admirals essentially preserved naval aviation's role in the postwar world, yet new carriers would be needed to implement it. Experience was demonstrating that existing carriers, designed to launch and recover propeller-driven aircraft, were having difficulty handling jet aircraft. On 30 October 1950, the secretary of the Navy approved a budget that included provisions for a new large-deck carrier. In its final form, the 1,036-foot, 60,000-ton carrier possessed a look all its own, featuring a small island structure, angled deck, and more powerful steam catapults capable of operating the Navy's largest heavy bombers. On 1 October 1955, the U.S. Navy commissioned its first supercarrier, USS *Forrestal.*

On 25 June 1950, North Korean tanks and troops swarmed across the 38th Parallel into South Korea in an attack that took the world by surprise. In keeping with a subsequent resolution by the United Nations Security Council, President Harry S. Truman committed U.S. military forces to battle. On 3 July 1950, USS *Valley Forge,* in concert with the British carrier HMS *Triumph,* launched the first naval air strikes of the war, attacking facilities at Pyongyang. In this engagement, U.S. Navy F9F-2 Panthers scored naval aviation's first jet kills, shooting down two North Korean Yak-9 aircraft. Eleven large attack carriers, one light carrier and two escort carriers took part in the conflict. Navy and Marine pilots provided close ground support throughout the war.

By July 1953, when the cease-fire was signed, U.S. Navy and Marine Corps aircraft had logged 189,495 sorties. Jets had successfully demonstrated their value in combat, and the helicopter had come of age as a transport and search-and-rescue platform. Most important, the aircraft carrier had demonstrated its value as a flexible platform for power projection in a limited war, a role that continues to this day.

Though the Korean War marked the dawn of the jet age, propeller-driven aircraft like the F4U Corsair and AD Skyraider logged 75 percent of all offensive sorties flown by carrier aircraft. The Corsair lived up to its World War II reputation as a tremendous close air support platform. Ten communist aircraft fell to Corsair guns during the Korean War, including a MiG-15 jet fighter. The Skyraider demonstrated its versatility in supporting troops or knocking out significant targets. In the latter mission it was greatly aided by the fact that it could carry as much ordnance as a B-17 Flying Fortress. The two mainstays in Navy and Marine Corps jet squadrons were the F9F Panther, a rugged aircraft built by Grumman, and the F2H Banshee by McDonnell.

The Navy lost its first aircraft over North Vietnam, an F-8, during a photoreconnaissance mission. Throughout the war, carriers stationed in the Gulf of Tonkin and the South China Sea provided close air support against the Vietcong and North Vietnam. Perhaps the crowning moment for naval aviation was during the fall of Saigon in April 1972. In an 18-hour period, Marine Corps helicopter pilots air-lifted more than 7,000 American and Vietnamese civilians from the U.S. Embassy compound to carriers waiting offshore.

In the early 1970s, the Navy introduced the F-14 Tomcat, and the Marine Corps accepted the AV-8 V/STOL Harrier. At the end of the decade, a new fighter-attack aircraft, the F/A-18 Hornet, was undergoing flight-trials. The submarine threat was confronted by the addition to the fleet of the Light Airborne Multipurpose System (LAMPS), which combined shipboard electronics with the SH-2D helicopter. During the 1970s, two nuclear super carriers, *Nimitz* and *Eisenhower,* were commissioned; *Carl Vinson* was launched.

As 1980 ended, the latest LAMPS version was under test in a new naval airframe, the SH-60B Seahawk. In addition, at decade's end the Navy's latest heavy-lift helicopter, the CH-53E, was ready for acceptance by a Marine Corps squadron. They are still operational in 2001.

In 1990, during Operation DESERT SHIELD, carrier- and land-based Navy aircraft provided logistical, reconnaissance, and interdiction duties during the buildup of Coalition forces. On 16 January 1991, the beginning of Operation DESERT STORM, Navy aircraft launched from carriers in the Red Sea and Persian Gulf. DESERT STORM saw the first combat use of the Navy McDonnell-Douglas F/A-18. DESERT STORM ended on 27 January 1991, but Navy and Marine aircraft continued to patrol the no-fly zones over Iraq after the turn of the century.

As of 2001, there were 12 aircraft carriers in the Navy's fleet. Nine were nuclear-powered, and the other three were fuel oil–powered. A thirteenth carrier, USS *Ronald Reagan,* will join the fleet in 2003. Naval aviation also played a significant role during the U.S. War on terror that began in 2001.

Henry M. Holden

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Unmanned Aerial Vehicles

Conveyances maintained in flight by aerodynamic lift and directed without an onboard crew. Remotely piloted vehicles and drones are the most common types of unmanned aircraft, but missiles and satellites also fall into this category.

Unmanned aircraft, distinct from piloted machines, became feasible with technological advances in aerodynamics and engines. The United States, Great Britain, France, and Germany experimented with uninhabited aircraft before World War II, with modest success. During the war, Germany successfully developed and employed the world's first cruise missile—the F2G76 pilotless aircraft better known to the world as the V-1. The United States also experimented with unmanned aircraft, developing time-expired bombers and the JB-2, a copy of the V-1 that became the basis for America's postwar program in uninhabited vehicles.

After World War II, airpower doctrine placed emphasis on the offensive capacity of unmanned platforms, insisting that missiles and automated machines would supersede manned aircraft. Consequently, missile research and development received great impetus in the United States, Europe, and the Soviet Union. Confidence in missiles continued through the 1950s and 1960s but waned gradually in the face of changing geopolitical circumstances, military realities, and financial constraints.

By the 1970s, unmanned vehicles, aside from crude missiles, had assumed largely defensive or support roles. The United States and the Soviet Union increasingly employed satellites for communications, surveillance, and navigation. During the Vietnam War, the United States Air Force used uninhabited aerial vehicles (UAVs) for reconnaissance, as did Israel during the Yom Kipper War and the Bekaa Valley operation. In the 1990s, advances in microprocessors, communications technology, and aerodynamics allowed the development of reconnaissance UAVs with longer range, better engine performance, and less vulnerability to enemy attack.

This new generation of machines, coupled with problems associated with personnel cost and availability and political sensibilities over casualties, encouraged military strategists to incorporate more UAVs into air operations.

Confidence in offensive systems, though less prevalent than in the 1950s and 1960s, has not vanished altogether, witnessed by growing interest in uninhabited combat aerial vehicles (UCAVs). Viewed as the ultimate extension of the standoff missile system, UCAVs attracted considerable attention in the late 1990s. In 1997, the United States and Britain launched feasibility studies on UCAVs. Enhancements in sensors, microprocessors, and communications seemingly solved many of the problems associated with these automated vehicles. Many technological challenges lay ahead, however, so it could be many years before UCAVs have a place alongside manned aircraft in combat.

Daniel E. Worthington

See also

Defense Suppression; Electronic Warfare; German Rocket Development; Missiles; Satellites;; V-1 Missile and V-2 Rocket; Vietnam War; World War II Aviation; Yom Kippur War

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U.S. Air Corps Tactical School (ACTS)

Developed doctrine for tactical and strategic airpower during the interwar years. Originally the U.S. Army Air Service School, it was authorized on 25 February 1920 at Langley Field, Virginia; the school was established to train Air Service officers with the rank of major or above in air tactics and operations, air defense, bombing tactics, staff operations, logistics, aviation, and combined arms operations. World War II demonstrated profound weaknesses in this doctrine. ACTS suspended classes in 1940 and was reorganized as Air University, which operates today at Maxwell AFB, Alabama.

The school opened on 1 November 1920. The school was originally nine months long but underwent many changes in subjects covered, time spent on subjects, and the school's total length. Because no other Air Service school taught tactics and administration, the Air Service Board changed the school's name to Air Service Tactical School (ASTS) on 8 November 1922 and lifted rank restrictions—sending many junior officers to the course to train them for all levels of command and staff assignments within the Air Service. Following the establishment of the Air Corps in 1926, Langley Field was selected to host several new units. The facilities could not support new units; the ACTS moved to Maxwell Field, Alabama, in the summer of 1931.

ACTS's most important contribution was the development of strategic bombing doctrine. Members of ACTS read Giulio Douhet but rejected his theories favoring nighttime area-bombing and developed air theory favoring strategic daylight precision bombing against economic targets rather than tactical ground support. ACTS airpower theory posited that fleets of bombers unescorted by fighters would perform precision daylight bombing on communications, industrial, and transportation targets. Altitude would protect these strategic bombers from enemy antiaircraft artillery; their speed, bristling armament, and disciplined formations would protect them against enemy interceptors. Only the experiences of World War II would reveal the weakness of this theory.

The Air Corps dramatically expanded following the outbreak of war in Europe. To fill new officer vacancies, the Air Corps suspended ACTS on 30 June 1940. ACTS was succeeded by the Army Air Forces School of Applied Tactics, which opened at Orlando, Florida, on 27 October 1942. This school explored current air operations rather than theory and doctrine. At the end of World War II, the School of Applied Tactics returned to Maxwell Field and was designated Air University on 12 March 1946. Air University now serves as the premier institution for commissioned and noncommissioned officer education, technology research, and doctrinal development for the United States Air Force.

Kevin Gould

See also

Command of the Air; U.S. Air Force Academy; U.S. Air Force Doctrine; U.S. Army Air Corps; U.S. Army Air Service; United States Air Force, Organizational History; World War I Aviation; World War II Aviation

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U.S. Air Force Academy

Established in 1954 at Lowry Air Force Base in Denver, Colorado; the cadet corps moved four years later to the Air Force Academy's current location along the Front Range of the Rocky Mountains just north of Colorado Springs. The campus is 7,000 feet above sea level and encompasses some 18,000 acres. A chapel constructed of stainless steel, aluminum, and glass with 17 spires rising 150 feet into the Colorado sky highlights the academy's unique architecture.

The mission is to inspire and develop outstanding young men and women to become Air Force officers of knowledge and character. The 500 military and civilian faculty members are dedicated to the intellectual, moral, and physical development of 4,000 men and women from all 50 states, territories, and several foreign countries. Cadets undertake a four-year course of study for a bachelor's of science degree and can select from 30 majors. The academy stresses four primary areas of military development: military art and science, theoretical and applied leadership, aviation science and airmanship, and military training.

The academy's vision is to be recognized as the premier developer of aerospace officers, leaders with impeccable character, and the essential knowledge needed to lead the Air Force into the twenty-first century.

Earl H. Tilford Jr.

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U.S. Air Force Doctrine

Formal USAF guidance on operational philosophy and how best to develop and use airpower and spacepower. Doctrine provides a common institutional perspective in operations, planning, training, and force development; however, it must be applied with flexibility and not become excessively rigid.

The USAF structures doctrine into three levels: *basic doctrine,* which provides broad guidance based on the most fundamental beliefs of the service (normally presented in the 1-series manuals); *operational doctrine,* which guides the organization and employment of large forces in a distinct environment such as a theater (normally presented in the 2-series manuals); and *tactical doctrine,* which explains the proper employment of specific weapons systems (normally presented in 3-series manuals).

Doctrine is developed primarily from the lessons of experience—combat operations complemented by exercises and simulations—and is shaped by theory, technological advances, national culture, perceived threats, and national politics and strategy. USAF doctrine rests heavily on the experiences of World War I and World War II and the theoretical developments in the Air Corps Tactical School during the interwar years.

Although USAF doctrine builds on traditional military history and military theory, the specific historical experiences, theories, and other factors that shape air doctrine emphasize basic operational characteristics that make airpower different than traditional surface forces. These characteristics—which continue to shape the nature of modern airpower doctrine—are speed, range, and flexibility stemming from the ability to move in three dimensions. Airpower leaders and theorists believed—and still believe—that to best exploit these characteristics several operational tenets should guide the employment of airpower.

A key underlying belief is that airpower is perhaps the most dominant factor in modern war. Therefore, all military operations should include control of the air as the first objective. Control of the air, as well as space, enables all other friendly air and surface operations to occur unchallenged by enemy airpower while also denying or limiting the enemy's ability to use the air and space environments. These basic characteristics give airpower the ability to rapidly concentrate firepower on key targets, leading to the belief that airpower is best used offensively.

A corollary concept states that air attacks can be decisive if focused on the right targets in a timely manner. Related to this perspective is the belief that centralized control is needed to ensure that finite air resources are focused on targets that best support national and theater objectives. This commitment to centralized control includes the belief that airpower should be organized separately from the surface forces and should be commanded by airmen who understand its advantages and limitations. The logical doctrinal extension of these concepts is the rationale for an independent air force that can directly engage the enemy country and defeat it by strategic bombardment, possibly without engagements involving surface forces.

This collection of doctrinal beliefs did not sit well with Army and Navy leaders, especially when the air arm was part of the War Department in the interwar years and during World War II. During the interwar years, Army aviation doctrine, as expressed in field manuals, emphasized the support role of the Army Air Corps in ground campaigns. Nonetheless, officers at the Air Corps Tactical School studied the potential of airpower and developed theories and operational concepts that emphasized the decisive nature of air weapons and especially the potential of strategic bombing using daylight precision-bombing tactics. This concept required the ability to understand the enemy and its economic structure, to identify the most important targets of the enemy state, and to accurately strike these targets—all leading to the collapse of the enemy economic structure, which would result in national surrender and the end of the war.

Although constrained by political realities, the concept of decisive independent strategic air operations became a core element of Air Corps and Army Air Forces institutional thinking and shaped planning before and during World War II; it also influenced the perspective of the independent United States Air Force after the war. The USAAF experience during World War II included success in both theater and strategic operations, with those efforts shaping the forces and doctrine of the USAF. The early lessons of World War II and the basic doctrinal themes described above were codified in War Department Field Manual (FM) 100-20 (*Command and Employment of Air Power,* 1943). FM 100-20 began by stating in bold capital letters: "LAND POWER AND AIRPOWER ARE CO-EQUAL AND INTERDEPENDENT FORCES; NEITHER IS AN AUXILIARY OF THE OTHER." FM 100-20 differentiated between strategic and tactical operations and established priorities within phases of theater operations, with air superiority first, followed by interdiction, and finally close air support.

The independent USAF did not immediately create new formal doctrine in the late 1940s, publishing the first basic doctrine document in 1953. Air Force Manual (AFM) 1-2, *United States Air Force Basic Doctrine,* incorporated the characteristics and core institutional beliefs that evolved before the creation of a separate service. AFM 1-2 also reflected the new technology of nuclear weapons, which strengthened the commitment to strategic offensive operations. Additionally, the security realities of the Cold War resulted in a heavy emphasis on deterrence. In 1959, the Air Force recognized the effects of missiles and space systems on military operations and used the new term "aerospace" to describe forces and operations. The Air Force renumbered the basic doctrine manual in 1964, making it AFM 1-1. This revision showed the influence of the national strategy shift to "flexible response," with an expanded discussion of aerospace operations across the spectrum of conflict, including a brief chapter on counterinsurgency operations. However, AFM 1-1 continued to emphasize the importance of deterrence, and the Air Force perspective on strategic and theater uses of aerospace power remained dominated by nuclear weapons. The service revised AFM 1-1 several times in the following 20 years, with adjustments reflecting changes in national security policy and efforts by the USAF to better explain its roles. The Air Force published a major revision of AFM 1-1 in 1992, with the new title *Basic Aerospace Doctrine of the United States Air Force.* This version followed the traditional doctrinal themes but added an extensive second volume containing a set of academic articles on military power and the application of aerospace power as a dominant force in modern warfare.

In recognition of the changes in the post–Cold War national-security environment, the Air Force created a new doctrinal structure in 1997. The new Air Force Doctrine Document (AFDD) 1, *Air Force Basic Doctrine,* continued to include the core characteristics and operational beliefs that are consistently found in the earlier versions of the service's manuals. Additionally, AFDD 1 highlighted the continuing technological improvements that significantly enhanced the combat potential of air and space forces and brought such forces to the point of reaching the potential originally conceived in World War I. The publication adds to earlier doctrinal statements by stressing the importance of the emerging area of information warfare and by emphasizing the ability of airpower and spacepower to conduct precision attacks at global ranges for strategic effects. AFDD 1 presents Air Force basic doctrine within the context of U.S. joint (multiservice) and combined (multinational) doctrine. However, the document strongly argues that recent experiences validate the traditional view of airpower advocates, proving "that air and space power does now have the potential to be the dominant and, at times, the decisive element in modern warfare." AFDD 1 further summarizes the long-standing threads of airpower doctrine by stating that "given the right circumstances, the speed, range, and stunning precision of air and space power—combined with the strategic perspective of its leaders—will allow it to dominate the entire range of military operations in the air, on land, on the sea, and in space."

Jerome V. Martin

See also

Air Interdiction; Air Superiority; AirLand Battle; Close Air Support; Field Manual 100–20; Strategic Bombing; Tactical Air Warfare; U.S. Air Corps Tactical School

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U.S. Aircraft Development and Production (World War I)

The first powered flight had taken place in the United States in 1903. But apart from the developmental flights by the Wright brothers and the work of Glenn Curtiss, little of consequence had taken place prior to U.S. entry into World War I. Consequently, when the United States finally declared war in 1917, its claim to greatness in aviation technology had been surrendered to the European countries.

Coming to this realization, the U.S. Congress tried to close the gap, budgeting a record $640 million appropriation for military aeronautics. The U.S. Army also sent a delegation (the so-called Bolling mission) to Europe to study aviation development and recommend steps to be taken back home.

The United States began building an aviation industry to build aircraft and engines (exactly which aircraft would have to await the recommendations of the Bolling mission); engines were another matter. Putting a handful of engineers in a hotel room for a few weeks, the United States miraculously produced a winning engine design—the Liberty—which began arriving at the front in the last few months of the war and powered U.S. aircraft (as well as some tanks) for years to come.

It was initially thought that large numbers of aircraft would be built in the United States and shipped to Europe for use by the Air Service. This plan was short-lived, however. America lacked the specialized industry needed to produce aircraft. Also, in light of the severe shortage of shipping, priority should be given to sending raw materials to Europe for conversion into finished products in French and British factories. Another reality, which argued in favor of reliance on foreign production, was the rapid pace of aeronautic design, which promised to render U.S. designs obsolete by the time they made it to the front. The decision was made, at least for the short term, to buy abroad.

Consequently, when U.S. units began making it to the front in the spring and summer of 1918, they were equipped with single-seat Nieuport 28s, SPAD VIIs and XIIIs, and Sopwith Camels along with two-seat Bréguets and Salmsons.

An exception to the buy-abroad approach was the production of the U.S. DH-4 (the license-built de Havilland D.H. 4 from Britain). U.S. DH-4s began arriving at the front in August 1918, and during the remaining months of the war several U.S. squadrons converted to them. They were the only U.S.-produced aircraft to see action in World War I.

An often overlooked area in which U.S. aviation proved successful was in the production of balloons. Goodyear and Goodrich, among other manufacturers, adapted their plants to produce the Caquot observation balloon and, by war's end, were in a position to have supplied not only U.S. needs but those of Britain and France as well had the war gone on into 1919.

James Streckfuss

See also
Bureau of Aircraft Production; Liberty Engine

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U.S. Army Aviation: Operations

Generally, aerial operations conducted by the U.S. Army in support of ground warfare.

During World War II, Army artillery employed light aircraft, mainly L-4 Piper Cubs (known as Grasshoppers), to adjust artillery fire. Air observation was made necessary because artillery could fire farther than ground observers could see. Grasshoppers proved adept in other missions as well: command and control, medical evacuation, liaison, emergency supply, direction of close air support, and reconnaissance. To support amphibious operations, the army configured LSTs as mini–aircraft launchers using the Brodie device, which enabled light aircraft to take off and land on a cable-trolley suspended over an LST. Small aircraft proved to be very survivable against enemy fighters and ground fire. After the war, aviation was extended to other Army branches.

The Korean War saw Army aviation used for the same missions as during World War II. Fixed-wing aircraft included the L-4 Cub, L-17 Navion, L-19 Bird Dog, L-20 Beaver, L-21 Super Cub, and L-23 Twin Bonanza. The L-4s and L-19s served most combat needs for observation of artillery fire, liaison, command and control, and reconnaissance. Acquiring its first helicopters in 1947, the Army found that they could perform most light airplane missions in Korea. One ubiquitous mission was medical evacuation, for which H-13s were well-suited. In 1953, the Army sent two H-19 transport helicopter companies to Korea to test their use in front-line supply and troop movement. They proved very suitable, and Army leaders planned for the organization of 12 transport helicopter battalions in the 1950s. The Army also envisioned replacing most fixed-wing aircraft with helicopters for combat operations because of their greater versatility.

The Vietnam War has been called the "Helicopter War" with good reason. After U.S. support began in 1961, few Army operations were begun without helicopter participation. To counter guerrilla ambush tactics against South Vietnamese troops, the Army sent H-21 Shawnee helicopter transport units to Vietnam in 1961. Flying South Vietnamese troops into combat, U.S. officers developed immediate response units (Eagle Flights) that used various tactics to defeat guerrillas.

Because landing zones came under enemy fire, the Army installed machine guns in H-21 doorways for suppressive fire when landing, but this was unsatisfactory. In 1962, the Army sent armed UH-1 Hueys to Vietnam to escort the H-21s and provide suppressive fire. These armed Hueys were too slow to accompany troop-carrying Hueys as they replaced the H-21s. Using Huey components, Bell Helicopter developed the AH-1 Cobra attack helicopter especially for the escort and fire-suppression roles. Critics predicted that all helicopters would be shot down, yet they proved tough and survivable.

Fixed-wing aircraft also had important missions in Vietnam. The CV-2 Caribou transport proved effective on short dirt strips for supplying Special Forces outposts. Although the Army acquired the OV-1 Mohawk for high-intensity warfare, it was also useful for surveillance in guerrilla warfare. The O-1 Bird Dog, a veteran of Korean, resumed its observation and reconnaissance roles. The U-1 Otter, U-6 Beaver, and twin-engine U-21 Ute served for utility and administration. In 1966, the Army transferred all Caribous to the Air Force, as it had claimed the fixed-wing air-supply mission for itself. In return, the Air Force dropped all claims to Army helicopter missions in the combat zone. This made possible the wider use of attack helicopters that the Air Force had opposed for impinging on the close air support mission.

President Lyndon Johnson's 1965 decision to send U.S. troops to fight the war brought a new phase to helicopter warfare. Trained in airmobile operations, the 1st Air Cavalry Division (Airmobile) demonstrated its ability to fight North Vietnamese regulars in the Ia Drang highlands. Utilizing close air support, armed Hueys, and artillery fire bases, the 1st Air Cav airlifted heliborne troops into the midst of an enemy stronghold.

The versatility of the 1st Air Cav was demonstrated in 1968 when it moved scores of miles north from An Khe to open a land route to besieged Marines at Khe Sanh. In Operation PEGASUS, the 1st Air Cav leapfrogged along Route 9, destroying enemy strongpoints and relieving the surrounded outpost. Soon after this action, the division air-assaulted into an enemy stronghold in the A Shau Valley against determined resistance. It prevailed again. In 1967, the 101st Airborne Division (Air Assault) relieved the 1st Air Cav and continued to demonstrate the effectiveness of a highly mobile division.

As Army forces in Vietnam increased, they had helicopter units attached to them in addition to their own organic aircraft. In order to control, maintain, and train these attached aviation units, the Army formed the 1st Aviation Brigade. The brigade adopted a policy of decentralized control of its units, sending them where they were needed most.

The survivability of helicopters in combat was questioned early in the war, but never as intensely as during Operation LAM SON 719. In February and March 1971, U.S. helicopters flew South Vietnamese troops into Laos to destroy huge enemy supply dumps and to disrupt enemy movements southward. The North Vietnamese countered with tanks and a sophisticated air defense. They shot down 107 helicopters, but Army leaders believed that the destruction of supplies justified the helicopter losses, set at one-fourth of 1 percent of sorties flown.

LAM SON 719 and the Easter Offensive of 1972 enabled the Army to employ helicopters as antitank weapons. Using mainly antipersonnel munitions during LAM SON 719, AH-1 Cobras destroyed six tanks and immobilized eight. After North Vietnamese armor poured across the demilitarized zone in the Easter Offensive of 1972, helicopters helped stop them. UH-1s armed with TOW missiles destroyed more than 50 tanks and other vehicles, the first major use of helicopters in the antitank role. During this offensive, North Vietnamese troops fired SA-7 heat-seeking missiles at the U.S. helicopters. This necessitated modifying helicopter exhausts to direct them upward into the rotor wash, thereby reducing the heat signature. Helicopters were also fitted with decoy flares.

In the 1980s, Army helicopters were used in two major operations. In the invasion of Grenada in 1983, UH-60 Black Hawks carried Delta Force troops to attack Richmond Hill Prison. Of the 14 Black Hawks engaged, seven were heavily damaged and one shot down, so the mission was aborted. Four Black Hawks carrying Rangers from Barbados attacked the Calvigny compound, resulting in the destruction of three upon landing due to heavy fire. They had no escort providing suppressive fire.

In the 1989 Panama invasion the Army made extensive use of helicopters already positioned at its Panamanian installations. When 82d Airborne Division units parachuted into Panama's airport, UH-60s picked them up for air assaults on key Panama Defense Force strongpoints. An AH-1 Cobra supported an air assault by two UH-60s into a prison holding political prisoners.

The 1991 Gulf War witnessed the successful use of Army aviation in midintensity warfare. Coalition strategy required a joint force to hold the southern boundary of Kuwait while an amphibious force threatened a landing on the Kuwaiti coast. Thus fixed in place to meet both threats, Iraqi forces would be unable to stop another secretly assembled joint force to the west from swinging shut like a giant door against the Euphrates River. This lightning movement would trap Iraqi forces inside Kuwait and permit their destruction in detail.

This giant Coalition door, hinged at the southern border of Iraq and Kuwait, consisted of the most mobile forces, especially VII Corps, heavy in armor, and the XVIII Airborne Corps, heavy in air-assault troops. Both corps had fighting helicopter units that had trained with their divisions.

The helicopters used included OH-58 Kiowas for scouting and targeting; AH-64 Apaches for antitank and reconnaissance missions; AH-1 Cobras for escort and antitank use; UH-60 Black Hawks for troop transport, command and control, and electronic countermeasures; and CH-47 Chinooks for troop transport, supply, and artillery placement. With their ability to fire 30mm cannons, 70mm rockets, and Hellfire laser-guided missiles, and to see through rain and dark, the Apaches had the greatest combat power.

The desert presented special problems for aviation. The trackless expanse provided few terrain features for navigation. The best navigational aids were Global Positioning System satellite receivers. Desert sand degraded rotors and engine parts, requiring frequent repairs. Hardpan was needed for forward refueling and rearming points to avoid sand stirred up in rotor wash. Heavy rains during a blowing *shamal* caused some helicopters to land and await clearer weather.

Before the ground war began, helicopter units conducted important missions. The first was to screen the assembling VII and XVIII Corps so that the enemy could not detect them. The second was to conduct reconnaissance into Iraq to find suitable places for forward refueling and rearming points. An important mission for Apaches was to destroy two Iraqi radar sites to give the Air Force a cleared airpath toward Baghdad. Flying low after dark to avoid detection, the Apaches launched missiles from a distance of 2 kilometers and destroyed the radars.

When the ground war began, Apaches and Cobras flew in advance of VII Corps to provide intelligence on enemy positions and to attack armor. Kiowas and Cobras flew flank security to warn of nearby Iraqi forces and to contact friendly units. To avoid VII Corps artillery fire, helicopters flew at least 12 miles in advance of the battle line. Apaches in advance of VII Corps had a field day killing armor and other vehicles.

The most mobile unit in the XVIII Airborne Corps was the 101st Airborne Division (Air Assault). It formed the edge of the swinging door and had to advance some 200 miles by the second day of battle. In the vanguard were Chinooks and Black Hawks, carrying troops, fuel, and ammunition. These supplies enabled Apaches to advance and close the door at the Euphrates. Near the river, Apaches of the 101st destroyed hundreds of vehicles that were backed up trying to flee Kuwait. They also blocked the causeway across the marshes with wrecked vehicles and destroyed a pontoon bridge across the river. Although a cease-fire was in effect on February 28, the Iraqi Hammurabi Division offered combat on March 1, and the Apaches destroyed its equipment. Overall, Army aviation proved indispensable in waging war against the well-armed Iraqi foe.

The fall 2001 U.S. war on terror opened a new chapter in Army aviation. The desert and mountain environment of Afghanistan provided formidable obstacles for successful Special Forces operations. The full measure of Army aviation was brought to bear against an entrenched and well-armed foe.

John L. Bell

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U.S. Army Aviation: Origins

Established in 1942 to assist the field artillery to adjust its fire, Army aviation has evolved over the years into a combat arm.

When the United States organized the Army Air Forces in 1941, AAF commanders believed that all strategic and ground support aviation should be under AAF control. The field artillery, however, had developed doctrine for indirect fire on enemy rear areas, places that ground observers could not see well. The artillery requested its own light aircraft to observe and adjust this fire. The AAF opposed the request because it planned to fly the mission. Its specially designed airplanes were not available by 1942, and the artillery was permitted to procure and fly its own airplanes, usually Piper Cubs.

During World War II, these small airplanes performed amazing feats. Besides adjusting distant artillery fire, they conducted other missions for ground forces: liaison, command and control, reconnaissance, flank security, emergency supply, medical evacuation, and direction of close air support. Despite AAF predictions that the Grasshoppers (as they were called) would be shot down, they proved very survivable. Logistical support was provided by both the AAF and the Army, an unsatisfactory arrangement. At war's end, Army aviation was made permanent and extended to all Army combat arms for uses they could determine.

After the war, the new U.S. Air Force and the Army engaged in disputes over roles and missions. They Army wanted to increase the types of missions it flew in order to secure greater mobility, but the Air Force opposed this, arguing that it could fly the missions. Given its emphasis on strategic bombing and air superiority, however, the Air Force was not responsive to Army needs. So the Army won more missions for its helicopters and larger airplanes than it was procuring. These missions included troop transport within the combat zone, air assaults and close air support, combat-zone reconnaissance, air movement of supplies and large weapons in the combat zone, and medical evacuation.

The U.S. Coast Guard is tasked with defense readiness, law enforcement, fisheries patrol, and environmental protection. Helicopters such as this one are often employed to perform these tasks. (Walter J. Boyne)

Army aviation also became more independent of Air Force control. After establishing an aviation center at Fort Rucker, Alabama, the Army gradually gained control from the Air Force of primary pilot training and logistical support.

The Army also examined doctrine for using aviation on the nuclear battlefield. This doctrine required the rapid dispersal and concentration of units and improved reconnaissance and surveillance systems. The so-called Howze Board of 1962 demonstrated the feasibility of air-assault operations. Its ideas were tested by the 11th Air Assault Division (Test) by 1965. The doctrine, except for the use of nuclear weapons, was further refined during the Vietnam War. New organizations to utilize this doctrine also proved viable in Vietnam: for example, the 1st Air Cavalry Division (Airmobile), the 101st Airborne Division (Air Assault), and the 1st Aviation Brigade. The older combat arms came to accept Army aviation as one of its own during the war, and acceptance was formalized with the creation of the Aviation Branch in 1983.

In the 1991 Gulf War, this new combat arm demonstrated its proficiency as aviation was integrated into division and corps operations. Attack helicopters killed tanks at great distances, destroyed radar stations, screened advancing forces, provided flank security, and closed enemy routes of escape. Scout helicopters located the enemy and laser-painted targets for all kinds of laser-directed munitions. Transport helicopters rushed troops and supplies forward to keep the enemy under fire and replenish aircraft. Army aviation has thus proven itself as a valuable combat arm in all kinds of warfare.

John L. Bell

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U.S. Coast Guard Aviation

The first practical steps toward a Coast Guard air unit occurred in 1915 when Lieutenants Elmer Stone and Norman Hall conceived of using aircraft for Coast Guard missions. The Coast Guard did not receive any money from Congress at the time to create an aviation unit. During the interwar years, the Coast Guard provided a number of important tasks, using flying boats for most of the missions.

The Coast Guard was incorporated into the Navy on 1 November 1941 and played a critical role in the defense of Greenland during World War II. Coast Guard aircraft flying from cutters helped locate German weather stations in the northern areas of Greenland. Coast Guard personnel captured the stations. Coast Guard aircraft performed rescues by flying through snowstorms and landing on the icecap to aid distressed Allied aircrews that had crashed while attempting to ferry aircraft across the Atlantic. In early 1943, the Coast Guard was tasked with developing the helicopter for antisubmarine warfare.

Today the Coast Guard is tasked with defense readiness, law enforcement, fisheries patrol, environmental protection, and homeland security. To function in these assignments, the Coast Guard flies some 200 aircraft from 27 air stations throughout the continental United States, Hawaii, Alaska, and Puerto Rico. The primary aircraft currently in the Coast Guard inventory are the HU-25A Guardian, the HC-130H Hercules, the HH-65A Dolphin, and the HH-60 Jayhawk.

Henry M. Holden

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U.S. Marine Corps Aviation

On 6 January 1914, Marine aviation was established as a separate unit within the U.S. Navy. At the time of U.S. entry into World War I, the Marine Aviation Section consisted of five officers, one warrant officer, and 30 enlisted men; equipment consisted of four Curtiss Type AH hydroplanes.

In August 1917, the Navy decided a naval base was needed in the Azores to extend convoy protection and to prevent German submarines from using the islands as refueling bases. The Marine Aviation Section arrived at Naval Base 13, San Miguel Island, on 21 January 1918. This unit was the first completely equipped U.S. aviation unit to leave the United States for service in the war.

Between the world wars, the only U.S. ground and aviation units actually engaged in combat were Marines. Marine aviation units served in the Dominican Republic from 1919 until July 1924; in Haiti from 1919 until 1934; and in Nicaragua from 1927 until 1933. During those deployments, Marine pilots not only experienced combat but also developed new tactics that would later revolutionize ground as well as air warfare.

In Nicaragua during 1927, Major Ross E. Rowell's unit was the first to employ dive-bombing against an organized enemy unit (Sandino's rebels). Rowell's pilots were also the first to employ air-to-ground communications in combat.

During World War II, the importance of aviation to Marine tactics was graphically demonstrated at Guadalcanal, where one of the first objectives of the assault was a partially completed Japanese airfield, later renamed Henderson Field. After the airfield had been taken, Marine aviation based on Henderson Field devastated overwhelming numbers of the Japanese air force and debunked the myth that Japanese pilots and their Zero fighters were invincible.

The most famous World War II Marine squadron, the Black Sheep, forever linked with its commanding officer, Major Gregory "Pappy" Boyington, fought in the Solomon Islands from August 1943 through January 1944. The Black Sheep counted eight aces and shot down 94 Japanese planes in addition to Boyington's 22.

The most successful Marine squadron was VMF-323, the "Death Rattlers," under the command of 23-year-old George Axtell. They shot down 124.5 Japanese planes and counted a dozen aces. In total, the Marine Corps had 24 aces who alone accounted for 362 enemy aircraft. Nine of the aces earned the Medal of Honor.

The Korean War was another testing ground for the air-to-ground team tactics, which had been developed over the preceding 50 years. During the Korean War Marine aviation began to perfect the utilization of helicopters and jet aircraft. The first Marine air offensive of the war occurred on 3 August 1950. Eight Corsairs of VMF-214 carried incendiary bombs and rockets and made numerous strafing runs on the port of Pusan.

The Chosin Reservoir campaign began on 27 November 1950 at Yudam-ni with 120,000 seasoned Chinese infantry troops surrounding approximately 17,000 troops of the 1st Marine Division and an additional 3,000 British Royal Marines. The fighting withdrawal of the 1st Marine Division from Chosin, in North Korea, along a harrowing mountainous route in sub-arctic conditions (1–9 December) is considered one of the greatest moments in the history of the Navy and Marine Corps.

From the start of the 68-mile battle to the sea, Marine aviation played a critical role. The tactical air control groups of Marine, Army, and South Korean units flew 3,703 sorties in 1,053 missions. This fierce, bloody battle, unparalleled in modern history, resulted in 15,000 allied dead or wounded. The enemy forces endured crippling losses, including 40,000 dead; thousands more went down with wounds and frostbite. One milestone for Marine aviation was its first jet squadron to see combat. VMF-311, under Lieutenant Colonel Neil McIntyre, began operations at Yonpo during the last few days of the Chosin breakout.

In the late 1950s, Marine aviation perfected the helicopter assault technique known then as "vertical envelopment." The Marine Corps and Army later employed this technique in Vietnam. Since then, Marine Corps aviation has continued to concentrate on close air support with the help of VSTOL aircraft.

Marine aviation was continuously represented in Vietnam from 1962 by the helicopter squadron of Task Unit Shufly. Up to 1964, helicopter squadrons of the 1st Marine Air Wing (MAW) had been rotated to Shufly about every four or five months. By the time the escalation of U.S. forces began in early 1965, the 1st MAW had considerable experience in the tactics and operation of helicopter troop lifts in Vietnam combat.

In 1965, the first short airfield for tactical support (SATS) was created at Chu Lai. SATS was a Marine aviation concept that provided a field complete with carrier deck–type arresting gear, a catapult, and a surface of interlocking lightweight metal alloy planking. The concept also included a tactical airfield fuel-dispensing system. By the end of May 1965, 4,000 feet of usable surface was down, and the first trap of an A-4 into the gear was made on 1 June. With the use of jet-assisted takeoff bottles, the first combat mission was launched from Chu Lai.

After Vietnam, Marine aviation took on a new look. In the late spring of 1971, the AV-8A, the British-built Hawker-Siddeley Harrier with VTOL capability, joined the Marine inventory. The second version, AV-8B built by McDonnell Douglas, joined the inventory in the mid-1980s. The Harrier allows a new approach to the operation of tactical aircraft not only from small ships in the amphibious force but also from relatively unprepared and dispersed sites ashore.

In the mid-1980s, Marine aviation began replacing its F-4 series fighter-attack aircraft with the F/A-18 Hornet. This agile fighter is an accurate attack weapons platform and is currently deployed on land and fleet aircraft carriers. The Marines also use the F-14 Tomcat, and the A-6F, an all-weather attack aircraft, increased capability.

The Marines currently have AH-1T Cobra attack helicopters, H-60 Seahawks, and upgraded CH-46 helicopters in inventory. The CH-53E Super Stallion, now in the inventory, is the world's most capable heavy-lift helicopter.

The MV-22A Osprey tiltrotor promises to exceed by a wide margin the best performance figures of any of the current helicopters. However, until apparent bugs are eliminated the Osprey is not operational; limited Osprey operations have been resumed.

Henry M. Holden

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U.S. Navy, Chief of Naval Operations (CNO)

The Office of the Chief of Naval Operations was established by Congress on 3 March 1915; it functions under the command of the secretary of the Navy and is responsible for fleet operations as well as preparation and readiness plans for use during times of war.

The coordination and management of the various departments of the Navy necessary to fulfill these duties included implementing decisions concerning what, how, and when material would be purchased from the private sector. Initially, the various Navy bureaus argued that only the secretary of the Navy possessed the authority to issue orders to them even though they cooperated with the CNO. One area of agreement between the bureaus and the CNO involved logistical support and building programs. The bureaus followed the recommendation of the CNO concerning issues such as modernization, scheduled repair of ships, and the appropriate number of officers and enlisted men. Any officer, captain or above, was qualified to be the chief naval officer until 1916, when the rank was raised to admiral. The first CNO, appointed on 11 May 1915, was Admiral William Sims Benson. Benson's reputation and the raging war in Europe persuaded the reluctant secretary of the Navy, Josephus Daniels, to rely on the judgment and expertise of the CNO. By 1917, the increased planning and procurement process elevated the CNO to a respected position with expanded responsibilities.

In the immediate post–World War I period, controversies arose over the authority of the CNO with concerns raised about civilian control. Congress created the position of undersecretary of the Navy to oversee and recommend changes for reasons of efficiency and economy and to maintain a stronger civilian presence. In 1924, the Navy, during a reorganization phase, added a Regulation granting the CNO authority over repairs and alterations to vessels and the supply of personnel to ensure readiness. The bureaus challenged the legality of these expanded powers, although continuing to cooperate with the CNO, until the beginning of World War II.

At the onset of that war, President Franklin D. Roosevelt signed Executive Order No. 8984 outlining the duties of the commander in chief of the U.S. Fleet, assigning overall authority to Admiral Ernest J. King, who in turn issued orders to the other commanders in chief. In December 1941, Admiral Chester W. Nimitz and Thomas C. Hart commanded the Pacific and Asiatic Fleets, respectively. CNO Admiral Harold R. Stark coordinated efforts with the commander in chief of the U.S. Fleet (Cominch), who assumed some of the functions of the CNO beginning in January 1942. An issue arose over the chain of command after the creation of that position, with King arguing that it should be under the authority of the CNO. President Roosevelt responded by issuing Executive Order No. 9096, combining the responsibilities of the CNO and the new position in one person. Interim CNO changes involved logistical functions with responsibilities divided between fleet maintenance, base maintenance, and the naval vessels and aircraft divisions.

The so-called Booz study, concluded in March 1943, recommended the implementation of additional changes within the logistical departments. Rejecting the traditional staffing procedures, which relied on line officers, the commission suggested that technical experts from the staff corps and Marine Corps within the various bureaus be assigned additional duty with the CNO. The officers would possess the advantage of knowing exactly where to obtain information quickly within their own bureau, thereby eliminating the lengthy correspondence process. Although the system worked well most of the time, there were a few occasions when logistical personnel disagreed with their bureau chiefs, calling into question the proper chain of command. The system continued throughout the war as the CNO relied on the bureaus to carry out the specifics such as purchasing and awarding contracts while the CNO focused on coordination efforts involving ships, aircraft, men, and supplies.

An attempt by Admiral King to reorganize the CNO met with resistance by Roosevelt but did yield one positive change. In August 1943, the secretary of the Navy established the post of deputy Chief of Naval Operations (Air; DCNO [Air]) responsible for policy, plans, and logistics of naval aviation. The DCNO (Air) operated under the vice Chief of Naval Operations. Other departments that operated under the CNO during the war included the Office of Naval Intelligence, Pan-American Division, Naval Communications Division, Hydrographic Office, the Naval Observatory, the Board of Inspection and Survey, Naval Transportation Service, and the Navy Inventory Control Office. On 15 March 1945, the General Board created the Ship Characteristic Board to handle issues involving the features of the ships, a task continued after the conclusion of the war.

After the Japanese surrender in August 1945, the CNO remained responsible for the demobilization of officers and enlisted men along with the Bureau of Naval Personnel. Admiral King argued that CNO functions transferred to Cominch during the war should be returned to the CNO. After Secretary of the Navy James Forrestal finally agreed with King, the two men met with President Harry S. Truman, who signed Executive Order No. 9635, placing responsibility for administrative, military, and business and industrial matters under the authority of the CNO. A recommendation was then made by Admiral King that Admiral Nimitz replace him as CNO. Secretary Forrestal favored Admiral Richard S. Edwards, but King argued that Nimitz had been the principal naval commander during the war and therefore should not be passed over in favor of Edwards. Admiral Nimitz became CNO on 15 December 1945. The overall impact of the war substantially increased the authority of the Office of the Chief of Naval Operations.

Since the end of the war the CNO, as the Navy's senior flag officer, continues to represent the Navy on the Joint Chiefs of Staff and is the principal naval adviser to the president and the secretary of the Navy. The CNO functions under the authority of the secretary and remains responsible for issuing commands, overseeing the use of resources, and coordinating the operation of the Navy.

Cynthia Clark Northrup

See also

U.S. Navy, Office of the Secretary

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Furer, Julius Augustus. *Administration of the Navy Department in World War II.* Washington, DC: U.S. Government Printing Office, 1959.

U.S. Navy, Office of the Secretary

U.S. Navy office that was first established in 1798 and continues through the present day.

Attacks by Barbary pirates on American vessels in the Mediterranean resulted in Congress approving appropriations for the construction of two frigates, *Constellation* and *Constitution,* in 1794. The lack of attention devoted by the secretary of war to the shipbuilding program resulted in the creation of the Department of the Navy with the secretary of the Navy as the chief officer on 30 April 1798. According to the statute, the secretary executed all orders from the president of the United States pertaining to the purchase of naval stores and materials, as well as the construction, armament, equipment, and employment of Navy war vessels. On 7 February 1815, Congress approved the appointment of the Board of Navy Commissioners, which handled matters pertaining to the construction, repair, and outfitting of ships; the secretary retained authority over military functions and command.

After the creation of the Office of the Chief of Naval Operations (CNO) in 1915, the role of the secretary of the Navy reversed. The CNO assumed control, under the secretary's command, of logistical planning while the secretary's staff focused on policy, business management, and other administrative matters. Policy, generated from the bureaus or other subordinates, reaches the office of the secretary for approval. After reviewing the recommendations and deciding on the appropriate policy, the secretary issues a directive to all departments providing the necessary guidance for implementation. The secretary, as a member of the president's Cabinet, advises the president, consults with Congress, and maintains regular contact with the secretary of defense and secretary of state. The secretary of the Navy also interacts daily with his subordinates, including the CNO, the commander in chief of the U.S. Fleet, the bureau chiefs, and the commandant of the Marine Corps.

Designed to ensure civilian control over the military, the Office of the Secretary of the Navy has been occupied by nonmilitary men throughout its history. Until World War II, 47 men held the position, but only a few had any naval experience. Throughout American history appointments to this office have been based on political considerations. Many of the early secretaries had been involved in shipping and brought civilian expertise to the military. Lawyers have dominated the position since the Civil War, and since the end of World War II businessmen with political skills, as well as business and engineering expertise, have filled the office. Their contacts in the private sector provided an opportunity for the quick addition of experts during times of war, as was the case during World War II.

Under the United States Code, the secretary of the Navy continues to conduct all functions of the Navy, including recruitment, organization, supply, equipment, training, mobilization, and demobilization, in addition to overseeing the construction, repairs, and outfitting of the Navy's ships.

Cynthia Clark Northrup

See also

U.S. Navy, Chief of Naval Operations

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U.S. Postal Air Mail Service

Early aerial trailblazing service (1918–1927). The U.S. Post Office Department officially took over the Air Mail Service from the Army Signal Corps in August 1918 following a string of embarrassing and deadly accidents. Under the leadership of the newly appointed superintendent, Benjamin Lispner, the legendary airmail pilots dealt with the hazards of inclement weather, unreliable engines, inadequate aircraft instrumentation, and nonexistent navigational aids to establish mail routes that connected the East and West Coasts of the continental United States. Flying war-surplus open-cockpit biplanes day and night in all kinds of weather, this club of courageous and highly skilled aerial mailmen captured the attention of the nation, much as the Pony Express riders had eight decades earlier.

By 1925, the Post Office had proven the practicality of flying the mail and, as originally planned, handed it over to private contractors. The Air Mail Act became law in February 1925, and by the summer of 1927 the Postal Air Mail Service was all but history. A staggering one-sixth of the pilots hired by the Post Office died flying the mail, but these intrepid pioneers paved the way for the safe day and night aerial cross-country navigation that would become so important in the future.

Steven A. Ruffin

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U.S. Strategic Bombing Survey (SBS)

A fact-finding and evaluation team envisioned by USAAF leaders and chartered by President Franklin D. Roosevelt to study the effects of strategic bombing on Germany and Japan. Employing more than 1,000 individuals—approximately one-third of whom were civilians—the SBS team compiled a huge mass of statistical data and wrote detailed reports of their findings that were published in 1945–1946.

Planning for the SBS began in early 1943, and teams began arriving in London before D-Day in preparation for a move to the continent. Franklin D'Olier, senior executive officer of Prudential Insurance, was selected as chairman. D'Olier then named noted civilians as his key subordinates and organized the SBS into several divisions that corresponded to target categories: oil, munitions, aircraft, transportation, morale, and so on. As the Allies moved across Europe, SBS teams followed, collecting material captured from German factories and government files, making on-site appraisals, taking thousands of photographs, and interviewing local officials, managers, workers, and inhabitants. The overall task of the SBS was to determine the effects of strategic bombing on the enemy's economy and, if possible, comment on the effectiveness of that bombing. In short, was a particular target actually destroyed and, if it was, what impact did that destruction have on the German war machine?

The Pacific SBS was also headed up by D'Olier, with Paul Nitze, another veteran of the European team, as deputy. The Pacific team, however, was plagued by interservice rivalry between the USAAF and Navy. Because the Navy had played no role in the bomber offensive against Germany, there was no reason to include naval officers on the European team. In the Pacific, however, the Navy had played a part—accounting for nearly 5 percent of the bomb tonnage dropped on Japan. As a result, naval officers were included on the Pacific team. The problems were immediate and continuous.

It was obvious to all that one of the major outcomes of the Pacific SBS would be to set the stage for the postwar U.S. defense establishment. The USAAF hoped to become a separate service based around a strategic bombing force employing atomic weapons. If the SBS reflected favorably upon the strategic bombing of Japan, this would further the airmen's goal. The Navy was adamantly opposed to a separate Air Force and therefore sought a report that reflected negatively on strategic bombing.

There were also systemic problems with the SBS teams and their methodology. The civilians who dominated the SBS included an excellent mix of bankers, industrialists, and economists. One of the division chiefs was even a specialist in public-polling techniques, invaluable in drawing up and conducting the thousands of SBS interviews. It did not, however, include any labor or union officials. Given the emphasis on determining the effect of bombing on worker morale, this was a serious oversight. Similarly, the armed forces of Germany and Japan were a major center of gravity in their own right, but there were no senior ground officers on the SBS team to lend their views of bombing's effect on this key target set.

Both the European and Pacific reports concluded that strategic bombing played a key role in victory but questioned some of the targeting decisions made by air leaders. For example, the SBS argued strongly for attacks on specific industries—oil, transport, chemicals, and utilities—rather than area-bombing of urban areas. Even so, the SBS painstakingly documented the enormous destruction that bombing caused to the economies of Germany and Japan. In addition, the Pacific team paid special attention to the effects of the two atomic strikes, as well as the subsequent Japanese decision to surrender.

Overall, the SBS reports are an extremely valuable historical resource. Altogether, 208 volumes were published on the European theater alone, another 108 for the Pacific. Most of these reports—examining strikes on specific factories, marshaling yards, utility plants, and the like—are extremely detailed and complete with maps, charts, and diagrams. Unfortunately, the sheer volume and detail make them so daunting they have been largely overlooked by historians. The two summary volumes are the most popular researchers and often quoted out of context. For example, the summary statement that airpower "was decisive in the war in Western Europe" has been cited on countless occasions, as has the statement in the Pacific summary that Japan "would have surrendered" by 1 November 1945 without the atomic strikes, without an Allied invasion of the home islands, and without Soviet intervention. Both statements are hotly debated even today.

The SBS remains the most detailed, accurate, and important source for the conduct and results of Allied strategic bombing in World War II.

Phillip S. Meilinger

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V

V-1 Missile and V-2 Rocket

The well-known German *vergeltungswaffen* (vengeance or retaliation or revenge weapons) were a last-ditch stand to stave off defeat in 1944–1945 by means of pilotless bombs that could be launched against London and other Allied targets. They reflected an interservice rivalry, with the later Luftwaffe V-1 missile project being launched out of concern over the V-2 army-controlled rocket program that was seen as endangering the Luftwaffe's strategic role. The Nazi SS seized overall control of both programs in early 1945.

The V-1 missile was a flying bomb, far cheaper and simpler than the V-2 rocket already under development, though in service both would carry similar 1-ton warheads. The Argus reaction propulsion jet engine, first flown in early 1941, had a loud "on-off" roar that inadvertently provided up to a five-minute warning to targeted populations. Design work on the airframe of what became the V-1 (the Fieseler Fi 103) began in March 1942, and it first flew with a Siemens guidance system at the end of 1942, launched from an aircraft over the Baltic Sea. It was referred to as an antiaircraft weapon to throw off spies and intelligence. Tests in 1943 were often frustrating failures.

Numerous production delays due to varied priorities, design and implementation problems, and Allied bombing of test and manufacturing sites meant that large numbers did not come off production lines until late 1944. The delay helped in one way, however, as intended launch complexes were simplified to portable 150-foot catapults. The V-1 was first launched into combat on 13 June 1944 (six of the 10 launched actually reached Britain), with nearly 140 French launch sites nearing completion. Soon, more than 100 per day were launched, though many failed to reach their targets. A piloted version was tested but never used in combat (the pilot would have bailed out before the final descent). The Allied invasion shut down the French launch sites, though final launches came from sites in Holland in March 1945.

All told, more than 32,000 V-1s were manufactured. Some 6,000 V-1s were fired at Britain, 3,400 of them at London alone. The British destroyed nearly 4,000 (1,847 by RAF fighters—including 400 mph Gloster Meteor jets—1,878 with antiaircraft guns, and 232 by cables attached to barrage balloons).

The V-2 rocket grew out of German experimentation and civilian rocket clubs in the 1930s. Active development of what became the V-2 weapon began in late 1938 after testing was conducted on several smaller versions. Development was slow due to shifting military priorities and the complex guidance and propulsion systems involved. Production of early V-2s required nearly 13,000 man-hours of effort, a figure that dropped with mass production. The long-range A-4 (later the V-2) experienced several failed launches before the first successful test flight of more than 100 miles over the Baltic Sea on 3 October 1942. More failed launches followed, and continuing development prevented mass production until late 1943. Extensive use was made of slave labor and underground manufacturing sites. Range slowly grew from 140 miles to more than 200 (some versions flew nearly 300). A projected but not built A9/A10 version would have true intercontinental range to bomb U.S. targets from German launch facilities.

Unlike the V-1, whose engine noise announced its presence, the V-2 struck with no warning at supersonic speed. The first combat launch against London came on 7 September 1944. Rockets were delivered by rail to forward launch points within range of London. The camouflaged rockets could be launched about 90 minutes after arrival even from an unprepared site.

All told, more than 6,500 V-2s were manufactured through April 1945. Many were destroyed at factories or on

In response to the overwhelming superiority of Allied forces over the Luftwaffe, the Germans put their energy into making superweapons like the V-1 Flying Bomb, seen here. (U.S. Air Force)

supply trains. Of the nearly 3,200 launched, slightly more than 1,400 were launched at Britain (mostly London) before operations ceased in early 1945. Some 1,600 were aimed at Antwerp and its suburbs. Lesser numbers targeted other sites.

Both the V-1 missile and the V-2 rocket came too late to effect the war's outcome, though damage and loss of life was extensive. More than 15,000 lost their lives and another 47,000 were wounded by these weapons. Both were area weapons used for terror, as neither could be accurately aimed at specific military targets. Neither weapon was used against the Eastern or Italian Fronts but instead were focused on major Allied cities and staging areas in the west. Capture of surviving copies helped fuel the postwar missile race.

Christopher H. Sterling

See also
Peenemünde; Speer, Albert; von Braun, Werhner

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Valencia, Eugene A. (1921–)

U.S. Navy commander; World War II Pacific ace. Eugene A. Valencia was born in 1921 in San Francisco. He entered naval service as an aviation cadet in 1941. Training lasted until April 1942. Between April 1942 and his subsequent assignment to USS *Essex* in February 1943, he served as an instructor-pilot. Aboard the *Essex* in November 1943, he scored four kills—three over the Japanese stronghold of Rabaul and one over Tarawa.

The events of 16 February 1944 proved to be a turning point in his career. After becoming separated from his wingman over Truk, he was jumped by several Japanese Zeros. After a lengthy running fight in which the Zeros expended a considerable amount of ammunition without hitting his F6F Hellcat, Valencia turned on his attackers. He quickly shot down three of the Zeros. After landing, the jubilant Valencia stated about his Hellcat, "I love this airplane so much that if it could cook, I'd marry it."

After returning from the Pacific for further training, Valencia developed his "Mowing Machine" method of combat. Over Truk he had noticed a flaw with Japanese fighter tactics that he could exploit. Three pilots were recruited and put through a grueling training program. In March 1945 they joined VF-9 ("The Cat o'Nines") flying off the new *Yorktown* (part of Task Force 58), after a brief but profitable stint on the new *Lexington,* where Valencia's "Flying Circus" used his new tactics and shot down six Japanese planes on their first combat mission.

Task Force 58 was involved in the Okinawa campaign from March to June 1945. An excellent example of Valencia's Mowing Machine tactics was 17 April during a combat air patrol. The four-plane Flying Circus engaged an enemy force of 40-plus aircraft that were attacking the fleet. By using Valencia's signature move, they were able to score 17 confirmed kills and four probables, with Valencia getting six himself.

They added 11 on another sortie and 10 more on 11 May. Eugene Valencia had 23 confirmed kills and was awarded the Navy Cross.

Scott R. DiMarco

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Vandenberg, Hoyt S. (1899–1954)

The second Air Force Chief of Staff (30 April 1948 until retirement on 30 June 1953), succeeding General Carl Spaatz. Vandenberg previously served as director of central intelligence from 10 June 1946 to 1 May 1947. Vandenberg's most significant contributions derive from his leadership at a time critical to the formation and early years of the Air Force. His exceptional managerial and organizational skills enabled the growth of the Air Force in general and the new Strategic Air Command in particular during a time of extreme budgetary competition among the services. These skills paid similar dividends during the gestation of the CIA and other U.S. intelligence collection and analysis agencies. Vandenberg was an extremely popular commander and was on equal terms with aircrews, Pentagon officials, and two presidents. Vandenberg AFB, California, is named in his honor.

Robert S. Hopkins

See also

Cold War; Strategic Air Command; Truman, Harry S.

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Vang Pao (1929–)

Major general in the Royal Laotian Army (RLA); an effective commander and the only member of the Hmoung ethnic group to attain the rank of general officer. Born in Nong Het, Laos, in 1929, Vang Pao first entered military service in the French colonial army in the late 1940s. He fought as an enlisted man, reportedly attaining the rank of sergeant, during the French-Indochina War.

The Geneva Agreement of 1954, which granted the kingdom of Laos independence as a neutral nation, also provided for a period of transition during which the French military trained the RLA. Accordingly, the French tapped Vang Pao to attend the Royal Military Academy at Dong Hene, where upon graduation he received a commission.

Vang Pao rose in rank and by 1960 was commander of an army of Hmoung irregulars. The Central Intelligence Agency noticed the military prowess of the Hmoung units far exceeded that of the rest of the RLA and sent U.S. Army "White Star" Special Forces teams to train and rearm Vang Pao's forces. The Hmoung operated primarily in the rugged mountainous areas north of the capital of Vientiane dubbed Military Region II, encompassing the strategic Plain of Jars and extending west to the border of North Vietnam.

From his mountain headquarters at Long Tieng, Vang Pao led a force of less than 22,000 guerrillas. The Hmoung kept North Vietnamese forces, numbering up to seven divisions, at bay throughout the war. In 1975, after the United States had pulled out of Southeast Asia, the coalition government collapsed and the communist Pathet Lao took over. Vang Pao moved to the United States to become the titular leader of the Hmoung in exile. He currently resides in California.

Earl H. Tilford Jr.

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VARSITY (1945)

Allied code name for the largest and most successful airborne operation in history; marked the end for Germany as Allied airborne troops mounted the final barrier and crossed the Rhine in 1945. By March 1945, only the Rhine separated the Allies from the German homeland. Plans were under way to cross the Rhine and capture the Ruhr, Germany's industrial center.

The area chosen by the Allies to make the amphibious crossing was between the German cities of Emmerich and Wesel. The 17th Airborne Division and 6th British Airborne Division assisted the crossing by seizing several important objectives in a massive daylight airborne assault. Six parachute battalions, including Canadians of the 6th Airborne division supported by glider troops from the Air Landing Brigade, dropped on 24 March 1945 as a complete force, avoiding the mistakes of Arnhem. Together with the U.S. 17th Airborne Division, the aim of the operation was to secure and deepen the bridgehead cast of the Rhine and then advance across country to the Baltic coast, 350 miles away.

Their initial objectives were the high ground overlooking the crossing point at Diersfordter Wald and the road and rail bridges over the River Issel at Hamminkeln. Flying in tight formation, 540 U.S. Dakotas carried 12 parachute battalions: five British, one Canadian, and six U.S., all closely followed by 1,300 gliders packed with troops. The Germans expected the invasion, and fighting on the drop zones was heavy. By the end of the first day's action, 1,078 men of the 6th Airborne Division had been either killed or wounded, with 50 aircraft and 11 gliders shot down. Weather for the drop was perfect, and almost everyone landed on their respective drop zone, although some ended up in the trees and were cut down by German machine guns as they fought to free themselves.

The 5th Parachute Brigade suffered heavily from casualties as mortar fire exploded in the skies around them during the drop. On the ground, the enemy had occupied almost all of the nearby houses, but by late afternoon the brigade's three battalions had cleared them. Within 24 hours, all objectives for the brigade had been achieved; as planned, ground forces of the Twenty-first Army Group joined the division across Germany. The bridges over the river were secured and the village of Hamminkeln captured. All objectives were achieved within 24 hours.

Albert Atkins

V-Bombers

Trio of British-built jet bombers of unique design. By the 1950s, Britain was able to design, test, produce, and field what was known as the V-Bomber Force of jet bombers—the Avro Vulcan, Handley Page Victor, and Vickers Valiant. Each featured engines buried in the wing roots and had a crew of five.

First to fly was the Vickers Valiant on 18 May 1951. A total of 49 were introduced into RAF service. These four-engine aircraft were of relatively conventional design with a tapered cylindrical fuselage with raised cockpit, shoulder-mounted semiswept wings, and a swept empennage with a mid-mounted horizontal stabilizer. Four 10,000-pound/thrust Rolls-Royce Avon 201 turbojets gave the aircraft a top speed of 567 mph at 30,000 feet and a maximum range of 4,500 statute miles. The Valiant was capable of conventional or nuclear operations and had a maximum bombload of 21,000 pounds.

The Valiants flew their first operational missions in the conventional role during the Anglo-French intervention in Egypt (October-November 1956). Britain's first atomic bomb drop occurred during a test on 11 October 1956, when a Valiant dropped a bomb over Maralinga in southern Australia. This was followed by Britain's first hydrogen bomb drop in the Pacific on 15 May 1957, during Operation GRAPPLE. These aircraft served in 10 RAF squadrons until January 1965, when metal fatigue resulted in the RAF withdrawing the Valiants from service and scraping them.

The second V-Bomber, the Avro Vulcan, was by far the most radically designed and longest-tenured of the V-Bomber Force. These aircraft had large triangular wings with a tapered circular cross-sectioned fuselage, a raised cockpit extending forward, and a large vertical tail. The Vulcan became the first large bomber in the world to employ a delta-wing planform. This configuration offered excellent load-carrying capabilities at high altitudes. Coupled with the wing's thickness-to-chord ratio, the aircraft was capable of carrying a large military payload and fuel internally.

The prototype Vulcan first flew on 30 August 1952. On 11 July 1957, RAF No. 83 Squadron became the first operational unit to be equipped with Vulcans. In 1959, the first successful inflight refueling experiments with the Vulcan was conducted with a Valiant K.1 tanker. Over time, increased engine thrust from Olympus engines improved performance. A total of 45 Vulcan B.1s served in six Bomber Command squadrons.

The Vulcan B.2 prototype made its first flight on 31 August 1957. A feature started with the second prototype B.2 was the tailcone extension, which housed electronic countermeasures gear. Power for the B.2s was supplied by either 17,000-pound/thrust Olympus 201 or 20,000-pound/thrust Olympus 301 turbojets, offering a top speed of 645 mph and a cruising speed of 620 mph at 55,000 feet. These Vulcans were capable of low-level penetration missions with new terrain-following radar, installed after 1966. The B.2's range was 4,600 statute miles, which was increased to 5,750 statute miles with one aerial refueling. Its offensive armament consisted of nuclear weapons or up to 21 1,000-pound conventional bombs carried internally, or a Blue Steel standoff bomb carried semiexternally. The Blue Steel was deleted from the inventory in 1969. A total of 89 B.2s were built and served in 11 bomber squadrons.

Britain's third V-bomber was the Handley Page Victor. The first production aircraft flew on 1 February 1956, and the first operational unit began receiving Victors in April 1958. These aircraft had a bulbous, double-lobed fuselage cross-section and a scimitar-wing planform. Four 11,000-pound/thrust Armstrong Siddley Sapphire 200 turbojets powered the aircraft to a top speed of 680 mph at 20,000 feet and 650 mph at 40,000 feet. Its range was in excess of 3,000 statute miles. These aircraft were capable of conventional or nuclear operations. Victor B.1s were converted into K.1 tankers and became operational in February 1965. Victor

B.1s equipped four bomber squadrons; K.1s served in four squadrons.

The Victor B.1s were superseded by the B.2s starting in February 1962. This series had a greater wingspan and was equipped with four 19,750-pound/thrust Rolls-Royce Conway turbofan engines. The Victor B.2s had a top speed in excess of 600 mph at 40,000 feet and a range of 4,600 statute miles. The*y* had a top speed of 640 mph at 40,000 feet and a maximum range of 4,600 miles. The aircraft was capable of carrying up to 35 1,000-pound conventional bombs or nuclear weapons internally. In addition, the B.2s could carry one Blue Steel standoff bomb semiexternally. The latter weapon was carried on the Victor B.2 BS, which was a low-level penetrator. The aircraft had an aerial refueling capability. A crew of five manned the Victors. Although the bomber versions of the Victor were removed from service in late 1968, 27 were returned to Handley Page for conversion into K.2 tankers. The K.2s carried 30 percent more fuel than the K.1s. The Victor B.2 BSs continued in service until 24 May 1974.

Alwyn T. Lloyd

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Verdun, Battle of (1916)

The first major campaign (February-July 1916) in which aircraft were deployed in a strategic instead of a purely tactical manner. Both sides brought large numbers of machines to the Verdun sector, although the French quickly outnumbered the Germans and retained the numerical advantage throughout the battle. Verdun was also the first battle in which massed groups of aircraft supported the infantry's movements.

The German airmen fought defensively throughout the battle. Their main strategy was an aerial blockade in which pairs of aircraft patrolled defined sectors of the lines to prevent French intrusion into German airspace. In practice, the Germans did not have the quantities of aircraft or pilots to make the blockade effective; the planes were spread too thin and the French could cross the German lines at will. Alternatively, the French deployed their aircraft offensively; the fighters hunted for German planes while unescorted two-seaters flew reconnaissance and artillery-spotting missions, trusting the fighters to prevent enemy attacks.

At this time most of the German pursuit pilots at Verdun were still flying obsolete Fokker Eindecker monoplanes, whereas France had introduced the fast and agile Nieuport 11 in January 1916. Rockets attached to the Nieuport's struts were responsible for bringing down five German observation balloons in one day. The French had two famous fighter squadrons at Verdun, the Groupe des Cigognes (Storks) and the Escadrille Américaine (later, Lafayette Flying Corps), but the Germans had not yet begun to organize the *jagdstaffeln* (fighter squadrons) that would prove effective at the Somme later in the year.

Critics have noted that the Germans failed to use their bombers to destroy French supply lines like the Voie Sacrée or the bridges over the Meuse. However, if indeed the Germans' plan was to bleed the French white, then allowing French troops and supplies to flow into Verdun was a strange strategy indeed.

Suzanne Hayes Fischer

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Versailles Treaty

The treaty that brought about the Armistice of World War I and set the table for German humiliation, resentment, and rearmament. Under the articles of the Versailles Treaty, signed on 28 June 1919, Germany was forbidden from having any kind of military aviation, save for 100 unarmed hydroplanes to be used in the search for submarine mines. Furthermore, a ban on production of civilian aircraft until June 1920 went into effect and was extended until all aircraft equipment had been turned over to the Allies. It was not until 5 May 1922 that Germany was again allowed to produce aircraft on its soil.

Despite such restrictions, the German General Staff (operating under the code name *Truppenamt* due to treaty restrictions) went about laying the groundwork for a new air force. The planning process, led by General Hans von Seekt, came to include tactics, psychology, and theoretical plans. Most important among these was the notion of an air force separate from the army. In addition, the limitations the Versailles Treaty imposed on a 100,000-strong army actually helped the General Staff select the cream of the crop from thousands of applicants.

Air officers, including war veterans, were spread among the General Staff and army and infantry offices. As of 1925, thanks to the German-Soviet Rapallo Treaty of 1922, pilots were also able to train at a German army base in Lipetsk, Soviet Union, where some 300 men were secret employees of the German army. For lack of flying in Germany, though, many officers often worked on promoting aeronautics among civilians, encouraging, for example, the development of gliding as a sport.

Another impact of Versailles, which restricted powered flight until the 1926 Paris Air Agreement, was the reversion to gliding for the training of pilots. During the Weimar Republic, Germans took to designing, testing, and competing in glider meetings. The result was the discovery of ascendant currents (warmer air layers), as well as the maintenance of flying know-how among younger pilots.

Following the beginning of treaty enforcement, which included Allied inspections on German soil, the German High Command began to consider ways to circumvent the treaty without risking sanctions. One option was to establish aircraft factories outside of Germany. For example, the Dornier aircraft factory, spun off from the Zeppelin concern, established a testing ground and assembly plant at Altenrhein, on Lake Constance across from the German bank, and another in Italy. The Junkers company also established a factory in Fili outside Moscow, which operated from 1924 through 1927 but never achieved solvency due to underproduction.

The permission to develop civil air routes was smartly exploited, as the German government heavily subsidized a series of airline ventures the Junkers company developed as far as Iran, China, and Bolivia. The competition among local German routes was such that the government forced a merger in 1925, which led to the creation of the first Deutsche Lufthansa, active until 1945.

Overall, then, the Versailles Treaty had limited long-term effect on Germany's airpower capability. Some historians argue that its terms actually encouraged German military planners to think creatively: studying foreign air forces, avoiding their mistakes, and coming up with new ideas.

Guillaume de Syon

See also

German Air Force (Luftwaffe); Goering, Hermann; Paris Air Agreement; Udet, Ernst

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Vertol (Piasecki) H-21

Military helicopter manufactured by Piasecki Aircraft and Vertol. Its prototype, the HRP-2, entered U. S. Navy service in 1950. Characteristics of the H-21 included a rear-mounted piston engine, tandem three-blade rotors, tricycle landing gear, twin vertical fins, and a bent fuselage that earned it the nickname "Flying Banana." In 1954, the U.S. Air Force and Army began receiving the H-21. The Air Force procured the H-21A Workhorse mainly for transport and search and rescue in the Arctic. The Army procured the more powerful H-21C Shawnee for troop movement and supply in the combat zone. The Shawnee could carry about 15 combat loaded troops or sling load about two tons. In 1956 the Shawnee was the first helicopter to fly non-stop across the U. S.

The French Army flew the H-21C in the Algerian War, 1956–1962, and the U. S. Army flew it in the Vietnam War from 1961 until it was phased out with the advent of the UH-1 Huey. The U. S. sold over 50 H-21C's to the French to test their use in combat against guerillas and develop military characteristics for a follow-on transport helicopter. The Shawnee proved survivable under direct fire. Many characteristics were proposed, including greater lift, wider doors, improved radios, self-sealing fuel tanks, and armor plate. In Vietnam the Shawnees were found to need machineguns in both doors for suppressive fire at the landing zone. Piasecki and Vertol produced at least 707 "flying bananas."

John L. Bell

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Verville, Alfred (1890–1970)

Aircraft designer. Alfred Verville was born in Michigan in 1890. His R–3 racer became one of the most advanced aircraft in the world.

Verville learned electrical engineering through a correspondence course, a humble start to a career as one of American aviation's most famous "backroom boys." These were the engineer-designers who, far from the limelight, drew their dream planes on paper, supervised their construction, then let the pilots shake out the bugs. His first aviation experience came with Glenn Curtiss's firm in Hammondsport, New York. Curtiss needed good engineers, and Verville worked on the experimental flying boat *America.*

In early 1915, Verville opened the General Aeroplane Company in Detroit. A year later he produced a beautiful fly-

Designed by Alfred Verville and built in the Sperry plant, the Verville Sperry was years ahead of its time with its low cantilever wing and retractable landing gear. Inadequate testing kept it from entering service. (U.S. Air Force)

ing boat. Sensing the imminence of war, he also put together an experimental pusher plane that mounted a machine gun—an American adaptation of the British "gun bus." Unfortunately, it skidded out of control on frozen Lake St. Clair and crashed. In 1917, Verville closed his shop and went to work for the Fisher Body Division of General Motors. His first task was to adapt the British de Havilland D.H. 4 for production as the DH-4.

At war's end, the Army Air Service invited Verville to join an inspection tour of France to see the latest designs in fighter aircraft. He returned to the Army's flight research center at McCook Field enthusiastic about the latest SPADs he'd seen in France. His first design for the Army, the VCP-1, derived from them. It was relatively fast but not maneuverable. Verville next adapted the VCP-1 into the VCP-R (Racer). Powered by a 600-hp Packard engine, it won the 1920 Pulitzer Trophy with an average speed of 156.5 mph.

Verville designed several notable aircraft, including the Sperry Messenger, a small aircraft for liaison and artillery-spotting. However, his most important design was a streamlined low-wing monoplane with retractable landing gear—the R-3 racer, three of which were built for the Pulitzer Trophy race.

Built by Sperry, the R-3 was handicapped when it was powered by a Wright engine, which vibrated so badly that it kept the R-3s from reaching their maximum performance in the 1922 Pulitzer race. It was not until 1925 that a Curtiss-powered R-3 won the Pulitzer with a speed of 215 mph.

In 1925, Verville resigned to enter private business. His company produced several very handsome aircraft but failed to win significant orders.

Henry M. Holden

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Vian, Philip L. (1894–1968)

Admiral of the British Fleet. Sir Philip Vian, born on 13 June 1894 in London, entered the Royal Navy in 1910. He served in destroyers and cruisers during World War I and the interwar years.

When World War II began Vian was commanding a destroyer flotilla. He distinguished himself during the next three years as an aggressive and effective leader of light forces, which led to his early promotion to rear admiral in July 1941.

In 1943, Vian commanded a squadron of five escort carriers charged with providing fighter cover and close air support for the Allied landings at Salerno, Italy. Force V, operating in light winds and confined waters, provided more than half of all air support during the operation's first four days. This success was tempered by Vian's inexperience in carrier operations, reflected in extraordinarily high operational losses.

Vian then led the Eastern Task Force covering the Normandy invasion before taking command of the British carrier squadron destined for the Pacific. After preliminary strikes against oil refineries in Sumatra, the carriers joined the U.S. Pacific Fleet in March 1945 at Okinawa. After two months of operations the British Pacific Fleet withdrew for refit before rejoining the U.S. Third Fleet for the final attack on the Japanese home islands. Vian's adaptability to carrier-warfare requirements supported the integration of U.S. practices into the Royal Navy; his drive was manifest in the fleet's accomplishments.

After World War II Vian served ashore and afloat until his retirement in 1952, when he was specially promoted to Admiral of the Fleet. He died at Ashford Hill, Berkshire, 27 May 1968.

Paul E. Fontenoy

See also

Fleet Air Arm; Kamikaze Attacks; Mediterranean Theater of Operations; Okinawa; Salerno, Battle of; Task Force 38/58

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Vichy French Air Force

Air force that operated under German occupation. Under the terms of an armistice signed with Germany on 22 June 1940, France was divided into an occupied German zone covering two-thirds of French territory, and an autonomous zone under the control of Marshall Philip Pétain, based in Vichy. Although the new state displayed collaborationist tendencies early on, it initially sought to maintain a modicum of autonomy and argued against certain German demands for disarmament.

Contrary to popular belief, the French air force led by General Joseph Vuillemin on 22 June still had almost 600 fighters, 300 bombers, and 200 reconnaissance aircraft, most based in France's North Africa colonies. Impressive as the numbers were, each squadron was incomplete, lacking spare parts, operational orders, and sometimes personnel.

General Jean-Marie Joseph Bergeret, who took part in the negotiations with Germany, sought to preserve the aircraft potential in Vichy territory and obtained from German and Italian authorities the specific term that planes stationed in France would be taken apart and stored rather than destroyed. Thus began a two-year period during which a part of the former French air force survived but undertook a different role.

Morale in the Vichy air force was a key element to survival. Many pilots were convinced that together they had shot down almost 1,000 enemy planes by the time of the armistice. This myth of 1,000 victories was carefully nurtured throughout Vichy's existence (the reality may be closer to 500 planes, but it is difficult to determine). The myth also helped convince the French that the 40 percent casualty rate among officers and 20 percent rate among NCOs and draftees incurred during the battle of 1940 was not in vain: France had not lost the air war; the fault lay elsewhere, or so did Vichy representatives present the facts. The blame was placed on England, and many French pilots who had thought of signing on with the RAF changed their minds following the British attack on the French fleet at Mers el-Kébir (an operation carried out to prevent Germany from using the ships.)

Domestically, the air force claimed that the poor quality of its machines was due to sabotage and paybacks (manufacturing was still slow, and many planes flew without quality checks because the air ministry had ordered quick acceptance due to war conditions). Consequently, Marcel Bloch (later Dassault), Emile Dewoitine, and Paul-Louis Weiller (a major air-transport manager) were all arrested. Meanwhile, General Bergeret was made secretary of the new Vichy air force in fall 1940.

The Vichy air force was assigned to train within the confines of the new French state and to protect its assets. This included defending the French navy fleet based at Mers el-Kébir in Algeria. This led to fighting between French and British fighters in July 1940 as the Royal Navy destroyed the French fleet. Ironically, having flown some 216 missions of all types within a week under difficult weather and conditions, French pilots had actually proven the need to maintain an air force and thus helped buy time with the Germans, who agreed to let the air force defend remaining French colonies.

Air Force engagements at Dakar, Gibraltar, and Syria against the Free French (who fought with the RAF) further affirmed the Vichy's plans for a new air arm. The planes used were the same as during the 1940 campaign against Germany but with different markings, as required by the Axis to help distinguish the French symbol from the RAF one.

Although the Vichy air force sought to maintain neutrality in its relations with Germany, there was in fact collaboration on several levels, in particular in the eastern Mediterranean, where German fighters used French bases while the latter were able to use the German phone system.

The end of the Vichy air force came in two acts. First, in fall 1942, the Allied landings in North Africa (Operation TORCH) led to a regrouping of French forces that had initially fought each other. In November, the chief of Vichy's North African arm announced to his troops that soon they would fight again, this time on the side of the Allies and using French and British aircraft.

In France proper, the German army invaded the so-called Free Zone, turning Vichy into a complete puppet government while destroying what was left of the air force there.

The Vichy air force thus became a dark page in the history of French airpower, whereby barely 10 percent of the 1940 air force followed the Free French and fought against them on several occasions. The dynamic of its operations depended heavily on Germany's willingness to let it operate, which was done only when the Germans felt they could gain a tactical advantage over the Allies.

Guillaume de Syon

See also
French Air Force

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Vickers Aircraft

British aircraft manufacturer. Vickers got its start in aviation with the *Mayfly,* an airship built for the British Admiralty in 1911. The humor in the nickname was well-timed, for the *Mayfly* broke in two as it was being moved from its hangar.

Other Vickers airships were much more successful, including the famous series of blimps used for antisubmarine patrol, as well as the successful R-100 in which the famous Barnes Wallis and author Neville Shute Norway had a part.

It was aircraft in which Vickers excelled, however, producing in World War I such notable designs as the FB.5 Gunbus and the Vimy, which made many notable postwar flights. The Vimy's success in conquering the Atlantic and flying to Australia paved the way for a long series of large Vickers biplanes that included the Vernon, Virginia, Valentia, and Vanguard. In 1929, Vickers acquired Supermarine but allowed it to retain its own identity.

Although not successful with fighter prototypes, Vickers did very well with single-engine bombers and torpedoplanes, producing the Vildebeest and the Vincent, both of which served in combat during World War II. The principal Vickers contribution to that war was the magnificent Wellington, in which Barnes Wallis again had a hand. The Wellington was the heaviest and best of the twin-engine bombers that the RAF could deploy when it entered the war; it was Bomber Command's mainstay until the arrival of the four-engine bombers. The Wellington featured geodetic construction, which could endure a great deal of battle damage without failure. There were 11,461 Wellingtons built, and they served in a variety of roles.

In the postwar years, Vickers produced a series of twin-engine transports that were widely used and included the Viking, Valetta, and Varsity. However, it was the four-turboprop Viscount that made history, for it became a very popular airliner and was purchased for use in the United States. On the military side, Vickers had great success with the four-jet Valiant, the first of Bomber Command's V-bombers.

In 1960, Vickers became part of British Aircraft Corporation and lost its identity as a manufacturer.

The last airplane designed and constructed solely by Vickers was the very advanced VC-10. It first flew on 29 June 1962 and featured four engines mounted on the aft fuselage. Only 56 were built, but they were well-liked by the public, and some were later converted to tankers for the RAF.

Walter J. Boyne

See also
V-Bombers

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Vickers Valiant

Britain's first V-bomber. Designed to a slightly lower specification level, it entered service more quickly than the more complicated Victor and Vulcan. Although aerodynamically simpler, the Valiant did feature some innovations, such as the electric-drive undercarriage and flaps.

Prototype flying began in May 1951 with service deliveries beginning in 1954, when they replaced the obsolete Avro Lincoln. The bomber version was followed into service by a reconnaissance model designated the Valiant B(PR)1, which was exclusively by No. 543 Squadron. With tanker capabilities added to the airframe, this became the B(PR)K.1, capable of bombing, reconnaissance, and aerial refueling duties. It was followed into service by the BK.1, which removed the reconnaissance capability.

The Valiant saw action during the Suez Crisis in October-November 1956. Aircraft from Nos. 138, 148, 207, and 214 Squadrons flying from RAF Luqa, Malta, dropped high explosive bombs on designated targets. One last very important bombing mission was Operation GRAPPLE. This was the deployment of the first British atomic weapon, released over Maralinga, western Australia, on 11 October 1956.

Production ceased with the delivery of the last of 104 ordered aircraft at the end of August 1957. The Valiant remained in service until August 1964, when the fleet was hastily grounded after the discovery of extensive wing cracks in the rear wing spar. The majority were quickly scrapped, although a handful remained in use for test purposes. One aircraft still survives in the Royal Air force Museum at Hendon.

Kev Darling

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Vietnam War

America's longest war; also, predominantly an air war in terms of resource allocation. Of the more than $200 billion expended while fighting the Vietnam War, fully half went to support air operations. Although occasionally pivotal, especially in support of ground operations, airpower was never decisive, and the role that airpower played remains controversial.

Some contend that if airpower had been used properly it could have produced a decisive victory. Airpower advocates point to results of Operation LINEBACKER II, the so-called Christmas Bombing of December 1972, as proof. Others contend that the United States used airpower to devastate the serene Southeast Asia landscape and decimate peace-loving peoples. Their claims that Hanoi and Haiphong were subject to carpet-bombing by B-52s and that napalm rained on villages are not supported by the facts.

Yet between 1962 and 1973 the United States dropped nearly 8 million tons of bombs on targets in Indochina. South Vietnam received about half that tonnage, making it the most bombed country in the history of aerial warfare. Nearly 3 million tons fell on Laos, and slightly less than 1 million tons were dropped on North Vietnam; Cambodia got hit with a 500,000 tons. The U.S. Air Force lost 2,257 aircraft to enemy action and accidents. Total U.S. air losses for the Army, Navy, Air Force, and Marines amount to 8,588 fixed and rotary-wing aircraft.

Airpower played a larger role than blasting enemy troop concentrations, railyards, petroleum storage facilities, and bridges in North Vietnam. Helicopters came into their own, and the Bell UH-1 Huey became the enduring symbol of U.S. operations. Indeed, choppers of all sorts provided unprecedented mobility for U.S. and South Vietnamese forces. They hauled troops, artillery, and supplies to dispersed locations throughout Vietnam and Laos. Medevac helicopters moved thousands of wounded soldiers from the battlefield to rear-area hospitals and life-saving surgery. Air Force transports moved troops and supplies throughout South Vietnam to keep far-flung outposts supplied even when isolated and besieged by enemy forces.

Innovation was key to the air war in Vietnam. Perhaps the most innovative application of airpower was the use of air-refuelable helicopters in search-and-rescue operations. The introduction of side-firing propeller-driven gunships for interdiction along the Ho Chi Minh Trail in Laos and their use in support of ground forces in South Vietnam, Laos, and Cambodia was another significant innovation. Revamped World War II–era propeller-driven aircraft like the North American A-26 and the Douglas Skyraider—with ruggedness, good loiter capabilities, and tremendous firepower—proved valuable for counterinsurgency as well as the more conventional role of close air support.

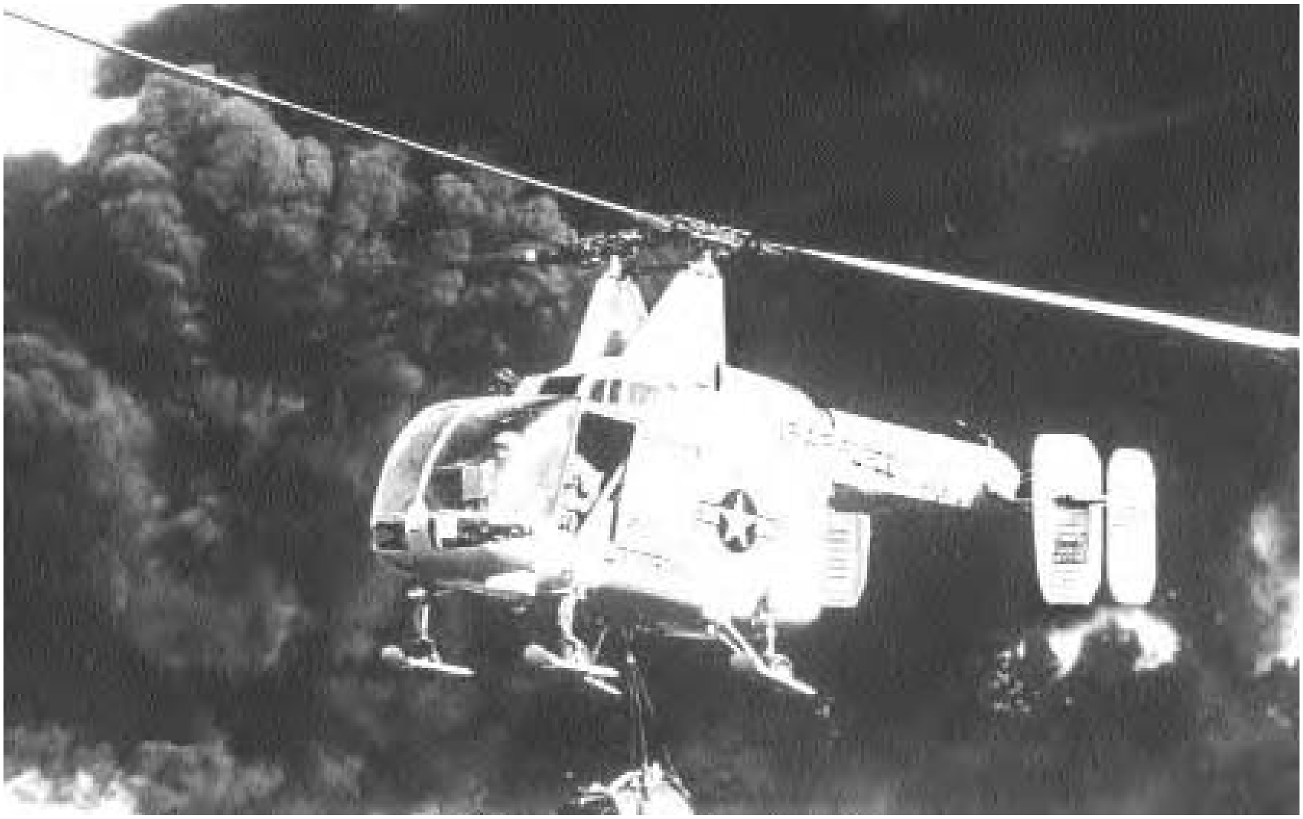
Throughout the Vietnam War, the preponderance of the air effort went to support ground operations. In this role, airpower was overwhelmingly successful in application and results. Indeed, superior firepower, especially in the ability of U.S. and allied forces to deliver high quantities of aerial explosives, kept allied combat deaths below 50,000 while accounting for much of the estimated 3 million in enemy killed.

Despite the dramatic accomplishments of airpower during the Vietnam War, the war itself remains an example of its misapplication and ultimate failure. Largely, the way airpower was used ran counter to the tenets of U.S. Air Force doctrine. Air Force generals argued in favor of a strategic bombing campaign against North Vietnam despite the fact that there was no industrial base to bomb and the diplomatic and political situation was such that terror-bombing, like that inflicted on Japan and Germany in World War II, was not a viable option. Indeed, one also can argue that the role airpower played in South Vietnam was strategically counterproductive. Vivid images of napalm engulfing village huts, of forests ravaged by Agent Orange defoliants, and of bombs cascading from the bellies of B-52s all seemed to support the claims of the antiwar movement. The case can also be made that the huge U.S. airpower capability, unprecedented mobility, and on-call close air support actually prolonged the war by perpetuating a strategic stalemate.

Although South Vietnam was the focus of aerial operations, so-called out-country operations accounted for an almost equal amount of effort. There were three major air campaigns aimed at North Vietnam, one of which, Operation ROLLING THUNDER, lasted almost four years (March 1965–November 1968). Laos, a nation of less than 3 million, received about 3 million tons of aerially delivered munitions. Most of this fell on North Vietnamese infiltration corridors (the Ho Chi Minh Trail) in sparsely populated eastern parts of the country. Cambodia was the target of secret bombing campaigns from late 1968 to early 1970 as well as B-52 raids until August 1973. The 500,000 tons of bombs that were dropped on Cambodia mostly fell into North Vietnamese base areas along the border.

Despite the magnitude of the bombing, only Operation LINEBACKER I, the airpower response to North Vietnam's Easter Offensive in 1972, was an unqualified success. The rest of the bombing either failed to achieve the stated objectives or the results are subject to conflicting interpretations.

PostScriptPicture
Vietnam



The role played by helicopters in Vietnam was so substantial that they became the symbol of American combat operations during the war. As well as hauling troops, artillery, and supplies to widely spread locations throughout Vietnam and Laos, they also served as medical evacuation helicopters. (Walter J. Boyne)

Perhaps the most controversial use of airpower was Operation ROLLING THUNDER, the longest bombing campaign ever conducted by the U.S. Air Force. Its objectives were to compel North Vietnam to stop supporting the Vietcong insurgency in South Vietnam and to stem the flow of troops and supplies moving to southern battlefields. It failed on both accounts. Despite U.S. efforts to compel North Vietnam to negotiate by escalating the bombing, Hanoi did not agree to begin talks until the United States stopped the bombing, which it did in late 1968. Bombing during ROLLING THUNDER also failed to interdict supply lines running into the South; in fact, the flow of troops and supplies doubled each year during ROLLING THUNDER.

In the wake of the Vietnam War, airpower advocates could also point to Operation LINEBACKER II as a success. Indeed, the bombing of military targets in and around Hanoi and Haiphong, when B-52s delivered 15,000 tons of bombs and fighter-bombers added another 5,000 tons, did achieve the limited objective of compelling North Vietnam to return to the Paris peace talks and, ultimately, led to the signing of the Paris Peace Accords of 23 January 1973. But what was gained at Paris—the return of U.S. POWs and the withdrawal of all U.S. forces from South Vietnam—hardly constituted an unambiguous victory; no great nation goes to war so it can retreat and get its prisoners back.

The air war in Vietnam remains controversial even today.

Earl H. Tilford Jr.

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Vietnamese Air Force (North)

Part of an air defense system that included antiaircraft guns, missiles, and radars. Outnumbered and technologically outclassed, the North Vietnamese Air Force (NVAF) inflicted many losses and forced the United States to divert valuable assets from strike missions to support missions.

NVAF inventory rose from about 30 aircraft in 1965 to 75 in 1968. By 1972, the NVAF had 93 MiG-21s, 33 MiG-19s, and 120 MiG-17s. These MiGs were small, highly maneuverable, and armed with heavy cannons as well as (on MiG-21s) two to four Atoll heat-seeking missiles. Under rigid ground control, MiGs lurked in the path of U.S. strike missions. MiGs used hit-and-run tactics, such as diving from high altitude at supersonic speeds through U.S. formations to fire a missile before escaping. U.S. aircraft were often forced to jettison their bombs, after which they could rarely accelerate fast enough to engage the nimble MiGs.

The NVAF exploited the U.S. rules of engagement. Airbases and surface-to-air missile (SAM) sites were built near so-called sanctuary areas (Hanoi, Haiphong, the Chinese border) that could not be attacked. Washington gradually lifted this restriction (1965–1968), but MiGs could always escape into Chinese airspace. The rule that MiGs could not be attacked without visual identification negated U.S. long-range air-to-air missile advantages and allowed MiGs to hide in clouds. President Lyndon Johnson's personal control of target selection caused U.S. forces to attack predictably and permitted the NVAF to concentrate defenses and establish ambushes. Finally, the United States could not attack the command-and-control system that was the key to the whole air defense network.

In air-to-air combat, the NVAF lost a total of 195 MiGs; the U.S. lost 77 aircraft. The NVAF was finally overwhelmed in 1972—bombers plastered NVAF airbases and U.S. fighters achieved a 5:1 kill ratio over the MiGs. However, the NVAF's true effectiveness should not be gauged by air-to-air losses but instead by comparison of the total offensive and defensive systems. Guns, missiles, and MiGs imposed heavy costs: from 1965 to 1968, the United States lost 800 men and 990 aircraft and spent $10 for every $1 in damage inflicted on North Vietnam. Moreover, the NVAF forced the United States to accompany each strike aircraft with many support aircraft (escorts, jammers, SAM suppression, tankers, airborne early warning, reconnaissance, combat search and rescue). This raised the cost of each mission and reduced the number of aircraft available to strike North Vietnam. In short, the NVAF was another component of Hanoi's successful overall strategy of attrition.

James D. Perry

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Vietnamese Air Force (South)

Originated in the air component set up to support the French-sponsored South Vietnamese Army in 1951. Initial equipment comprised a handful of Morane-Saulnier MS500 observation aircraft assigned to the 1st Aerial Observation Squadron. Further units were formed for similar purposes, with some receiving the Dassault MD-315 Flamant. The collapse of the French forces at Dien Bien Phu in May 1954 allowed the North Vietnamese to negotiate a favorable settlement. This also halted the expansion of the South's air force.

The South Vietnamese Air Force (SVAF) came into existence on 1 July 1955 as an independent branch, more in name than reality, as it had 58 aircraft available for operations and some 1,300 personnel. Initial equipment was Cessna L-19s and a handful of Douglas C-47s.

As part of its anticommunist policy, the United States began to back the government of Ngo Diem. First aircraft deliveries were via French advisers still in-country, but with their withdrawal the United States began to supply directly under the auspices of the Military Assistance Program with assistance via the U.S. Military Assistance Advisory Group Vietnam.

By 1960, the strength of the SVAF consisted of one squadron of F-8F Bearcats, two of C-47s, two with the L-19, one with the Sikorsky H-19, and a mixture of other types including trainers. The failure of the reunification election led the North to begin insurgent attacks into the South. As these escalated, the state of the SVAF aircraft became perilous; they were literally falling apart.

This led the United States to supply a batch of refurbished Douglas Skyraiders; spare parts problems led to grounding, and the old workhorses were replaced by North American T-28D Trojans. To support the SVAF, the USAF created the 4400th Combat Crew Training Squadron, which rapidly brought aircraft and crews up to a reasonable standard.

A change of government by coup in late 1963 was to lead to a greater expansion of the SVAF. The prime strike aircraft became the Douglas A-1 Skyraider with other types being supplied in sufficient numbers to make a difference. These included the Cessna 0–1 and the Douglas C-47.

Jet aircraft were to make an appearance on the front line in 1967. The types supplied included the Northrop F-5A/B and the Cessna A-37. There was even a combined unit flying the Martin B-57, although they were soon returned to USAF. The gunship concept made its first appearance during the Vietnam War, and so it comes as no surprise to find the

SVAF receiving quantities of the AC-47 and the Fairchild AC-119. Transport types were also upgraded from U.S. sources with versions of the C-7, C-47, C-119, and C-130 Hercules entering service. Observation and utility types were also replaced, the squadrons upgrading to the U-6 Beaver and various versions of the Bell UH-1 helicopter.

A negotiated cease-fire in 1973 had resulted in the South Vietnamese displaying some ire at being left out. In an effort to placate them and prepare the country for the imminent withdrawal of U.S. forces, Operations ENHANCE and ENHANCE PLUS were put into effect, with massive amounts of aid arriving for the air force. This included Northrop F-5s, Cessna A-37s, C-123s, and more C-130s.

All of the extra aid was in vain, as many aircraft were grounded due to lack of spares. This situation and the general corrupt nature of the government led the North Vietnamese to begin a concerted attack against the South. Although the pilots of the SVAF fought valiantly, losses mounted and their retreat continued. On 22 April 1975, the town of Xuan Loc was captured, and for all practical purposes the war was over. Some offensive sorties were flown by the SVAF, although more effort was expended on escaping the country. Some of the abandoned aircraft were later to see further service with the renamed the Vietnamese People's Air Force.

Kev Darling

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Vimy Ridge, Battle of (1917)

During World War I, the general theory was that Vimy Ridge held the key to victory in France. If the heights of Vimy could be ascended by Allied forces, the army could break through and destroy the enemy. The war would at last be over. Had the Russians been more a problem to the Germans in the east, and had the British better exploited their victory, the theory might have proven correct.

Nevertheless, capturing Vimy, an effort that arguably made Canada a nation, proved immensely important the following year, when continued possession by the Germans may have been enough to have made their offensive a war winner.

At Vimy, aerial cooperation in spotting for the artillery, despite the heavy snow, proved crucial to the creeping barrage that paved the way for the infantry attack—a hint of the combined arms doctrine that would continue to develop the following year.

James Streckfuss

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Vo Nguyen Giap (1912–)

Vietnamese general and minister of defense. Born in 1912 in the province of Quang Binh, Giap joined the Indochinese Communist Party in the 1930s. When the Communist Party was outlawed in 1939, he fled to China, where he became a military aide to Ho Chi Minh, helping to shape the Vietminh movement.

Giap became the Vietminh's foremost military commander during the war with the French (1946–1954), planning and directing the military operations that culminated in the 1954 defeat of the French at the Battle of Dien Bien Phu. Giap became North Vietnam's minister of defense and commander in chief of the People's Army of Vietnam (PAVN). As such, he planned the 1968 Tet Offensive and the 1972 Easter Offensive, both tactical disasters for the communists.

His reputation tarnished by these successive failures, General Giap was eased from power in favor of his protégé, PAVN Chief of Staff and Senior General Van Tien Dung. It was Dung, and not Giap, who planned and commanded the final offensive that defeated South Vietnam in 1975. Giap retired from politics in 1982.

James H. Willbanks

See also

Vietnam War

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Voisin Aircraft

French aircraft manufacturer founded by Gabriel Voisin (1880–1973), one of the great French aviation pioneers. He started to build sailplanes in 1905, then in 1907 he created the first flyable French biplane (the Delagrange No. 1, named after its buyer). Many derivatives followed until 1910, when they were supplanted by the Canard. This was selected by the French and Russians as pusher types that reached Escadrille V.14 in 1913. The metallic-tube structure was revolutionary, generating low weight with ruggedness, and was later found on all Voisin designs. The pusher formula made it possible to put a gunner in the front cockpit; this became the Voisin canon design.

At the beginning of World War I, only two escadrilles possessed some Voisins. The Type III made history when, on 5 October 1914, the two-man crew achieved the first official aerial victory against an Aviatik B.1. It was as a bomber that the Voisin Type V became famous, being able to launch 220 pounds of bombs. Big raids, with as many as 75 planes, started over Germany in May 1915, but heavy losses obliged the airmen to operate at nighttime only. Produced in great numbers, the Voisin pushers were also used by the British, Italian, Russian, and Belgian services. Improved models like the Type VIII reached the front in November 1916, and some new Type Xs were in use in 1918. A total of 3,470 were produced in France during World War I, plus 112 in Italy, 1,120 in England, and several hundred in Russia.

Immediately after the war, Gabriel Voisin left the aeronautical business to launch a much more peaceful car factory. The mechanical genius of Gabriel Voisin had found another and more peaceful field of expression.

Stéphane Nicolaou

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Voskhod

A temporary replacement for the Soviet Union's Vostok program; the circumstances of its creation pertain directly to the space race. In the wake of President John F. Kennedy's challenge to land a man on the moon, Soviet premier Nikita Khrushchev had hoped to initiate a swiftly successful program of his own. However, informed that such a project would take several years, he reportedly approached rocket designer Sergei Korolyov about beating the United States in placing several people into space in one shot.

Korolyov came back with Voskhod: a Vostok capsule with the ejection seat removed and replaced with two or three seats. Added support equipment raised the capsule's weight to more than 5,200 kilograms, which exceeded the lifting thrust of the booster used to date, the A-1 (a modified R-7 ICBM). Consequently, an improved booster, the A-2, was developed, which included an upper stage, Venus, designed to reach higher orbits.

Voskhod 1 involved the first multiple-crew flight when on 12–13 October 1964 cosmonauts Vladimir Komarov, Boris Yegorov, and Konstantin Feoktistov boosted into orbit. The cramped conditions in the capsule prevented them from wearing their pressure suits, which also explains why Korolyov was intent on having the men remain aloft no more than 24 hours. A second Voskhod mission in March 1965 carried two cosmonauts, Pavel Belyayev and Aleksei Leonov, and demonstrated the feasibility of extravehicular activity (EVA) when Aleksei Leonov left the cabin briefly.

Although further Voskhod flights were planned, including one in which female cosmonaut Valentina Tereshkova would have performed an EVA, none materialized, and Soviet manned space activities stopped until April 1967. The Voskhod missions are generally viewed as the equivalent of the U.S. Gemini program, undertaken for the purposes of gaining experience in preparation for sending men to the moon. Indeed, construction and testing of a new vehicle, Soyuz, was under way to replace Voskhod and lay the basis for an expedition to the moon. Testing first took place in November 1966 and February 1967 in the form of KOSMOS flights.

Guillaume de Syon

See also

Korolyov, Sergei; Soyuz Space Vehicle; Vostok

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Voss, Werner (1897–1917)

German World War I ace. Voss transferred to aviation in 1915, having already won the Iron Cross, second class, with his Hussar regiment on the Eastern Front. Arriving at Jasta 2 late in 1916, Voss had time to form a friendship with Manfred von Richthofen prior to the latter's transfer the following January. When Voss's score began to rise in the new year, a friendly competition developed between the two, and Voss became Richthofen's chief competitor for the top spot on the aces' list.

By September, Voss was leader of Jasta 10, part of Richthofen's Flying Circus, and his score stood at 48. On the evening of 23 September, in an attempt to make it 50, Voss encountered RAF No. 56 Squadron's B Flight under the command of James McCudden. In what many consider the epic aerial combat of World War I, Voss was killed as he fought alone against seven SE 5as.

James Streckfuss

See also

German Air Force (Luftwaffe)

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Vostok

The first Soviet manned space program. It successfully launched Cosmonaut Yuri Gagarin on 12 April 1961 and concluded with *Vostok 6* in 1963, which carried the first woman in space, Valentina Tereshkova. The capsule, designed by Sergei Korolyov's OKB-1 design bureau, consisted of two parts. A reentry sphere, thus shaped because of known speed range, widest internal volume for a given external surface, and the option of shifting the center of gravity (removing the need for attitude-control rockets), contained the cosmonaut, the survival gear, and the ejection seat. The other part, a service module, contained the electrical batteries, thrusters to orient the machine, and the retro rocket.

Several empty test capsules were launched in 1960 and failed, but on 19 August of that year a machine identified alternately as *Korabl Sputnik 2* or *Sputnik 5* fitted with a heat shield and parachute system carried two dogs, rats, mice, and fleas. The test went well, and a fourth rocket was sent up. But the new RO-7 engine, built into the third stage of the modified Semyorka booster, failed. The dogs on board survived the fall.

Another three test capsules were fired, the last one, *Korabl Sputnik 5*/*Sputnik 10*—carrying a dummy in a spacesuit and a dog in March 1961—flew successfully and cleared the way for *Vostok 1* on 12 April 1961. *Vostoks 3* and *4,* as well as *5* and *6,* carried out double flights; although they were not designed for docking, they succeeded in coming within a few kilometers of each other.

Vostok was essentially a low-orbit manned program, which nonetheless gave the Soviet Union an advantage in the space race as well as the basis for the development of multiple-crew programs, such as Voskhod and Soyuz. In addition, modified Vostok capsules were used to orbit reconnaissance satellites that could function for up to 10 days in orbit. Thus, an entire camera system was placed where the cosmonaut would have been. The first successful launch of this modified Vostok was *Kosmos 4* on 26 April 1962.

Guillaume de Syon

See also

Gagarin, Yuri; Korolyov, Sergei; Soyuz Space Vehicle; Sputnik; Voskhod

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Vought A–7 Corsair II

Conceived as a replacement for the Douglas A-4 Skyhawk; it ran counter to the "faster is better" trend of the 1950s and 1960s. The Navy's requirement was purposefully kept subsonic in order to minimize costs. At first glance the A-7 gives the appearance of being a stubby F-8 Crusader, resulting in the nickname "Sluf" (Short little ugly fellow). The A-7 first flew on 27 September 1965 and was followed by 395 A-7As and A-7Bs.

In order to secure Pentagon permission to begin the development of the F-X (what became the F-15), the Air Force agreed to purchase A-7s as its primary attack aircraft. Although intending to order a minimal-change version of an existing type, the Air Force soon specified a more powerful engine, better avionics, new guns, and additional external weapons. The A-7D thus emerged as a much more capable platform than the early Navy variants. The first flight was on 5 April 1968; a total of 459 A-7Ds were produced.

The Navy was impressed and ordered 597 slightly modified A-7Es, although the first 67 were produced as A-7Cs without the new engine. Fifty retired A-7A/Bs were rebuilt into two-seat TA-7C trainers, and 31 A-7Ds were converted into similar A-7Ks. Exports were limited to 60 A-7Hs and five TA-7H two-seaters purchased by Greece in 1975 (later supplemented with 36 former Navy A-7As and TA-7Cs), as well as a number of A-7As and TA-7Cs that were rebuilt and supplied to Portugal as A/TA-7Ps.

Dennis R. Jenkins

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Vought Aircraft

U.S. manufacturer of attack, fighter, reconnaissance, and scout-bomber aircraft for the U.S. Navy and Marines.

Chauncey M. "Chance" Vought (1888–1931) and Birdseye B. Lewis (1888–1917) founded the Lewis and Vought Corporation in New York on 18 June 1917. Lewis left for France shortly afterward as a member of General John J. Pershing's staff and later perished in an airplane accident. Thus, Vought managed the firm from the beginning and subsequently dropped Lewis from the company's name.

The son of a sailboat designer, Vought often applied terms of the sea to his aircraft. He studied engineering at several schools before being attracted to aviation by the Long Island Air Meet of 1910. In the seven years preceding U.S. entry into World War I, Vought became chief engineer for the Aero Club of Illinois and editor of *Aero and Hydro* magazine. He also served as engineer with Glenn H. Curtiss, Orville Wright, and Glenn L. Martin before establishing the partnership with Lewis.

Vought's seventh design with his own company, the VE-7, proved successful. After testing the two-seat tractor-style biplane at McCook Field (later Wright-Patterson) in March 1918, the U.S. Army Air Service contracted serial production with Vought. More important for the company's future, the U.S. Navy purchased 129 advanced versions of the VE-7 as its primary fighter after World War I. As a result, the VE-7 would be the first airplane to fly from the deck of a U.S. aircraft carrier (the USS *Langley*) in October 1922. The same year, Vought constructed an observation plane (UO-1) that incorporated the newly designed Lawrance radial engine, precursor to the Wright Whirlwind. Used as the standard catapult plane for U.S. Navy battleships and cruisers, the land model flew with the U.S. Marines. The improved O2U held world records in 1927 for speed, altitude, and endurance for Class-C seaplanes. It was also the first U.S. Navy plane to have an official nickname—"Corsair."

By the time Corsair II (O3U) appeared in 1931, United Aircraft and Transport Corporation (later, United Technologies) had purchased Vought Aircraft Corporation. Vought moved from New York to Connecticut and eventually occupied the facility and shared the name of another United subsidiary, Sikorsky. Based on the work of Igor I. Sikorsky, Vought-Sikorsky became the first U.S. company to mass-produce military helicopters (the R-4, R-5, and R-6). Meanwhile, during the course of the 1930s Vought moved toward building all-metal low-wing monoplanes such as the Vindicator scout-bomber (SB2U). In 1938, a team led by Rex Beisel designed the definitive Corsair (F4U), a high-performance fighter built around a Pratt and Whitney Double-Wasp engine. Arguably one of the best fighter aircraft of World War II, the plane then served as a tactical weapon in the Korean War and remained in production until December 1952.

With the start of the Cold War, security concerns prompted the U.S. government to insist that aircraft companies disperse from the Northeast; Vought moved to Dallas in 1950. Four years later, to avoid antitrust suits, the company broke away from United to become Chance Vought Aircraft, Inc. By that point, the corporation had merged its airframe designs with turbojets. In 1953, Vought won a contract for a prototype of the U.S. Navy's first Mach 1 fighter. Tested in 1955, the Crusader (F-8) achieved high-speed flight while maintaining low-speed characteristics for carrier operations via a hydraulically operated variable-incidence wing. The design won the prestigious Collier Trophy in 1957. After joining the Ling-Temco-Vought conglomerate in 1961, the firm signed a U.S. Navy contract in 1963 to produce the last Corsair, a subsonic attack plane designated the A-7. Four hundred durable A-7s were manufactured; they supplied close support for U.S. ground forces during the Vietnam War. It could not produce another winning Corsair design. As a result, the Dallas facility manufactured components for other airframe companies such as subassemblies for the McDonnell Douglas (Boeing) C-17 military transport. Northrop Grumman bought the plant in September 1994, then sold it in July 2000 to the Carlyle Group, which resurrected the Vought name for the facility.

James K. Libbey

See also

Curtiss, Glenn Hammond; Martin Aircraft; Pershing, John Joseph; Sikorsky, Igor I.; U.S. Marine Corps Aviation; United Aircraft Corporation; United States Navy, and Aviation; USS Langley; Vought A-7 Corsair II; Vought F4U Corsair; Vought F-8 Crusader; Vought VE-7; Wright, Orville

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Vought F4U Corsair

U.S. World War II fighter. Rex B. Beisel and his team designed the F4U around Pratt and Whitney's 18-cylinder R-2800 radial engine and the large propeller necessary to absorb its power. The type's most characteristic feature, its inverted gull wing, allowed use of a shorter, stronger undercarriage than required by a straight wing and also reduced aerodynamic drag. The prototype exceeded 400 mph during official trials, a first in the U.S. Navy.

Design began in 1938, and the prototype made its first

The distinctive shape of the Chance Vought F-4U made it a favorite with the public, and its performance made it a favorite with the U.S. Navy and Marine pilots who flew it. (U.S. Navy)

flight on 29 May 1940. Production commenced a year later, and the last of 12,582 aircraft, an F4U-7 for France, was delivered in December 1952.

Despite the Corsair's stellar performance, the Navy initially confined F4U operations to shore-based squadrons, because undercarriage bounce and restricted forward view were undesirable characteristics for deck landings. In the hands of Navy and Marine aviators, as well as New Zealanders, Corsairs proved themselves ashore in the Southwest Pacific. Royal Navy carrier operations vindicated the Corsair, so it deployed aboard U.S. carriers from late 1944.

During World War II, Corsairs excelled both as interceptors and in ground attack. Postwar, jets took over interception, but F4Us became important as night-fighters and retained the ground attack role. In Korea, Corsairs shone in both missions. French Navy Corsairs also saw action in Indochina, Algeria, and at Suez. Corsairs went to Argentina, and some fought each other during the so-called Soccer War between Honduras and El Salvador.

The Corsair was among the best Allied fighters of World War II and certainly the finest carrier fighter of its era.

Paul E. Fontenoy

See also

Boyington, Gregory; Dien Bien Phu, Battle of; Fleet Air Arm; French Naval Air Force; Suez Crisis; U.S. Marine Corps Aviation; United States Navy, and Aviation; Vought Aircraft

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Vought F–8 Crusader

U.S. fighter of the 1950s and 1960s. The F-8 Crusader exceeded Mach 1.0 on its first flight (March 1955) and had a significant performance advantage over its land-based contemporaries, largely as a result of imaginative engineering design and extensive use of magnesium alloy and titanium. The first fighter version of the Crusader, the F8U-1 (F-8A), entered service with the U.S. Navy in December 1956, followed in 1958 by the RF-8A, which had the armament and fire-control system replaced by cameras and additional fuel. The F-8C and F-8D both had improvements to the power plant and radar, and the F-8E had an improved radar and ground attack capability.

The F-8 was a hot aircraft for its time, capable of reaching

40,000 feet less than three minutes after brake release. It required skill and judgment to fly, particularly from an aircraft carrier, and had spectacular stall and spin characteristics. It was a dangerous opponent in a dogfight; very maneuverable, it could take battle damage and had very good fuel reserves. During the Vietnam War, the F-8 had the highest kill-to-loss ratio of any U.S. aircraft. A total of 1,261 Crusaders were produced in fighter, photoreconnaissance, and fighter-bomber versions.

Andy Blackburn

See also
Aircraft Carriers, Development of; Vietnam War

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Vought VE-7

Originally designed by the Lewis Vought Company as a two-seat advanced trainer that could be used to instruct U.S. pilots during World War I. It was the first aircraft extensively tested by the U.S. Army. Although the first plane was delivered on 11 February 1918, full production did not begin until after the end of the Armistice, by which time the need for advanced trainers had been reduced. At the time of its introduction, the VE-7, which was powered by a 150-hp Hispano-Suiza engine, received high praise and was considered to be one of the finest training aircraft yet produced.

In 1919, a VE-7 entered in the New York–Toronto Air Race and placed first in its class. This brought it to the attention of the U.S. Navy, then seeking an aircraft that was suitable for shipboard use. The Navy issued an initial order of 20 planes, stipulating they be equipped with the improved 180-hp Hispano engine that the Wright Aeronautical Corporation was producing under license.

The Navy introduced a single-seat fighter version, designated the VE-7S, in 1921. The redesignated VE-7SH was later converted for catapult use by replacing the undercarriage with a centerline float. A carrier version, the VE-7SF, had flotation equipment and arresting gear fitted. One of the latter was flown from USS *Langley*'s flight deck for the first time on 17 October 1923 by Lieutenant Commander Virgil C. "Squash" Griffin.

Thomas Wildenberg

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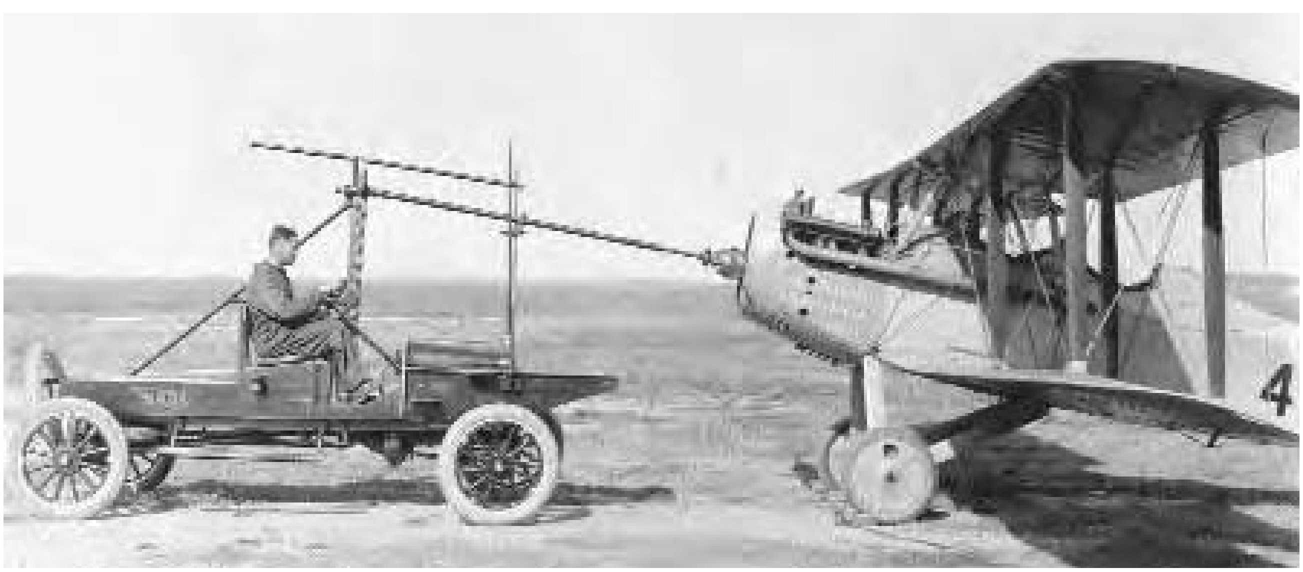

Variations of the Huck starter were used all over the world, some up through World War II. Here it is being prepared to crank up a Vought VE-7. (U.S. Navy)

W

Wake Island, Battles of (1941–1945)

U.S. outpost in the central Pacific Ocean captured by the Japanese shortly after the attack on Pearl Harbor and held until the Japanese surrender. Shortly before Pearl Harbor, a squadron of PBY Catalina patrol planes and Marine Fighter Squadron 211 (VMF-211) flying Grumman F4F-3 Wildcats had reinforced Wake's tiny garrison of Marines. Despite a warning message and diligent patrol efforts, the initial Japanese air raid caused considerable damage to the poorly equipped garrison, especially the fighter squadron, which suffered more than 50 percent personnel casualties. The remaining fighters were instrumental in repulsing the initial Japanese landing effort on 12 December 1941. This triumph, including the destruction of several Japanese ships, gave the United States a tremendous boost in morale.

Rear Admiral Husband Kimmel, commander in chief of the Pacific Fleet, hoped to reinforce and hold Wake, perhaps even trapping the Japanese fleet in a naval battle that would avenge Pearl Harbor, but on 17 December he was removed from command. His temporary replacement, Vice Admiral William Pye, decided that reinforcing Wake was not worth the risk to his reduced forces. He aborted the Wake relief mission to the dismay and scorn of more aggressive Navy and Marine Corps officers. The Japanese then reinforced their invasion force with aircraft carriers returning from Pearl Harbor. On 22 December, VMF-221 lost its last fighter. Despite the conversion of squadron personnel into infantrymen, the garrison, with Japanese troops on the island, surrendered on 23 December. Its garrison entered captivity for the remainder of the war.

As the United States assumed the offensive in the Pacific, the Japanese garrison prepared to fight to the end, but U.S. airpower and naval power made an invasion unnecessary. U.S. forces simply bypassed Wake, cutting off virtually all supply routes. U.S. Army and Navy aircraft pounded the Wake garrison, but starvation hurt the Japanese more than the air attacks. Following the Japanese surrender, Wake Island returned to U.S. control.

Grant Weller

See also

Consolidated PBY Catalina; Fletcher, Frank Jack; Grumman F4F Wildcat; Halsey, William F.; Japanese Army Air Force, Imperial; Japanese Naval Air Force, Imperial; Prisoners of War; U.S. Army Air Forces; U.S. Marine Corps Aviation; United States Navy, and Aviation

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Warden, John A. III (1943–)

U.S. Air Force colonel John Ashley Warden III was born in McKinney, Texas, on 21 December 1943. He earned a bachelor's degree from the U.S. Air Force Academy in 1965, a master's degree from Texas Tech University in 1975, and graduated from the National War College in 1985. He has more than 3,000 flying hours in aircraft such as the F-15, F-4, and OV-10 and flew 266 combat missions as a forward air controller during the Vietnam War. After serving as commander of the 36th Tactical Fighter Wing at Bitburg AFB, Germany, Colonel Warden headed the Air Staff's Warfighting Deputy Directorate.

In this capacity, his team developed alternative airpower strategies to the existing USAF doctrine, and Generals Norman Schwarzkopf and Colin Powell have credited him as the strategic architect of the 1991 Gulf War air campaign. Warden's ideas on the application of airpower have influenced USAF thought throughout the 1990s.

He served as special assistant to the vice president of the United States and as commandant at the USAF's Air Command and Staff College. Following retirement in 1995, he has developed new approaches to business and war strategy—the so-called Prometheus process. Colonel Warden's decorations include the Distinguished Service Medal, Defense Superior Service Medal, Legion of Merit, Distinguished Flying Cross, and the Air Medal with 10 Oak Leaf Clusters.

John Andreas Olsen

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Warning Systems

Ground-based and airborne air defense systems designed to detect and track incoming aircraft. By the end of World War I, early warning had evolved from rudimentary beginnings to a series of well-organized and reasonably effective systems. These generally relied on human observers to report aircraft sightings to a central information center, which would in turn direct resources to respond to the threat. Though the Mark I Eyeballs and simple radio transmitters of World War I would be supplemented in later years with a succession of technologically more complex systems, this would remain the basic model of air defense command and control throughout the twentieth century.

In World War II, radar revolutionized air defense. For the first time there was at least a realistic possibility of intercepting large formations of incoming aircraft before they reached their target. The most dramatic example of the importance of radar—and of warning systems in general—was the successful air defense system deployed by the British during the Battle of Britain. Later in the war, Germany and Japan were forced to form extensive early warning systems of their own, prompting U.S. and British strategic bombing forces to develop a variety of exotic technological countermeasures to confuse enemy detection devices. Engineers and physicists were proving as important as soldiers and airmen in this new kind of wizards' warfare.

Of course the ultimate technological innovation to emerge from World War II was the atomic bomb, and the advent of nuclear weapons raised the stakes enormously. Whereas in the past destroying 5–10 percent of attacking aircraft would be considered a success, with nuclear weapons every single bomber not intercepted could mean the loss of an entire city. Despite these odds the United States, driven by deep fears of a nuclear Pearl Harbor, led the way in creating a series of early warning systems deployed across the top of North America and later in space. In the 1950s, the United States and Canada deployed a series of early warning radar chains such as the Mid-Canada, Pinetree, and Distant Early Warning radar networks. Yet even the detection—let alone interception—of every incoming bomber during an intercontinental attack remained a dubious proposition at best.

In response to the threat of ICBM attacks, the United States in the 1960s deployed a second generation of early warning systems, including the Ballistic Missile Early Warning System and a variety of satellites. Though attempts were made at creating antimissile defenses, realism dictated that the primary role of air defense control centers, such as the massive North American Air Defense Command complex buried within Cheyenne Mountain, Colorado, would be primarily one of generating warnings sufficient only to initiate retaliation, not conduct a successful defense. The era of mutual assured destruction had arrived.

Partially as a result of its own devastating experience with surprise attack during World War II—the German invasion of 22 June 1941—the Soviet Union suffered from a similar sensitivity to surprise nuclear attack. Though it was hampered by a smaller economic and technological base than the United States, the Soviet Union eventually was able to field its own series of early warning systems throughout the 1960s and 1970s. Geography and limited resources prevented other nuclear powers such as Britain and France from creating warning systems as elaborate as those of the superpowers, but each could hope to generate at least enough warning to make its second-strike capability secure.

During the later years of the Cold War, and especially in the post–Cold War era, warning systems designed primarily for tactical use grew in importance. During the Vietnam War aircraft began mounting large search radars and using inside controllers to direct the interception of enemy aircraft. The extremely lopsided success of the Israeli air force in combat with Syrian aircraft over Lebanon in 1982 owed much to Israeli use of E-2 airborne early warning (AEW) aircraft, an example repeated by the Coalition's use of E-3 AEW aircraft during the 1991 Gulf War with Iraq. Just as the tactical early warning problem appeared to have been mastered by such systems, however, the United States threatened the long-term dominance of radar and other early warning methods with its introduction of stealthy aircraft designed to evade radar and other standard means of detection.

David Rezelman

See also

Airborne Early Warning; Ballistic Missile Early Warning System; Britain, Battle of; College Eye Task Force; Defense Support

Program, and Missile Detection; Distant Early Warning; Electronic Warfare; KOSMOS; Mutual Assured Destruction; Radar; SAGE Defense System; Satellite Command and Control; Satellites; Signals Intelligence

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Warsaw Pact Aviation

Generally, the air forces of Albania (1949–1968), Bulgaria, Czechoslovakia, East Germany, Hungary, Poland, Romania, and the Soviet Union, which was the pivot of airpower. The Soviets were also the main source of weaponry, munitions, repair, parts, supplies, and training during the pact's existence (1955–1991).

Since World War II, Moscow directed and supplied the creation, reorganization, and expansion of aviation in its Eastern European satellites (in Bulgaria, Hungary, and Romania, air forces were forbidden under the 1947 peace treaties). Top-ranking Soviet air officers even commanded Polish and Hungarian air forces until 1956.

The air forces of non-Soviet members were organized as tactical air forces and equipped by the end of the 1980s mostly by Soviet-made aircraft. These included MiG-17, -21, -23, -27, and -29 fighter/fighter-bombers; Su-7, -20, and -25 ground attack aircraft; Mi-24 helicopter gunships; Tu-134, -154, Il-14, An-2, -24, and -26 transport aircraft; and Mi-2, -4, -6, -8, and Ka-26 helicopters. There were also widely distributed Czech trainers (L-29, L-39), Polish-made helicopters (Poland and Czechoslovakia), and some French Puma and Alouette helicopters (Romania).

Organization and force structure varied among non-Soviet nations. Air/air-defense forces of Bulgaria, Czechoslovakia, Hungary, and Romania formed one component within their armies. The East German army air/air-defense force consisted of three main arms of service. The Polish air force (the largest in Eastern Europe) and air defense developed into a unitary service in the late 1980s.

Czechoslovakia's aviation was usually most modern within the pact, while East Germany's had the closest operational subordination to the Soviet allies. The pact also experimented in the 1950s with an integrated Bulgarian-Hungarian-Romanian fighter regiment, and beginning in 1962 the air defense systems of East Germany, Poland, and Czechoslovakia were fully integrated with the Soviets' air defense.

At its height, the total combat airpower of non-Soviet members was 2,346 aircraft and 393,000 men. Additionally, Poland had 57 aircraft and 2,300 troops in naval aviation. In the event of war in Europe, most of these forces and their infrastructure had to be operationally subordinated to the command of Soviet tactical aviation deployed in East Germany, Poland, Czechoslovakia, and Hungary. They also had to be supported by the Soviet Long Range Aviation.

Despite the formidable numbers, about 91 percent of non-Soviet aviation was obsolete, its electronic systems and combat characteristics far less advanced than those in NATO. Nevertheless, Warsaw Pact–era aircraft remain in service in all the former member states; even Germany inherited some from East Germany.

Peter Rainow

See also

Antonov Aircraft; Ilyushin Aircraft; Mikoyan-Gurevich Aircraft; Mil Aircraft; Poland, Aircraft Development and Production; Polish Air Force; Soviet Air Force; Soviet Aircraft Development and Production; Tupolev Aircraft

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Washington Naval Conference

The 1921–1922 series of meetings between the United States, Great Britain, Japan, France, and Italy; arguably the first modern international arms-limitation effort. It produced three major agreements, all of which set limits on the production of naval weapons and territorial aggrandizement, but otherwise they helped create the environment that led to the outbreak of World War II. The Five Power Naval Treaty defined the ratio of battleships among the signatories, halted territorial expansion (especially in the Pacific), and limited the development of U.S. and British bases in the Pacific, heightening Japan's importance in the region. The Four Power Pacific Treaty (which excluded Italy) guaranteed the security of each signatory's Pacific island territories but refused to go beyond diplomatic efforts to resolve potential disputes. The Nine Power Pacts (which added Belgium, the Netherlands, China, and Portugal) reaffirmed the Open Door Policy in China. It was primarily an economic declaration, and none of the signatories agreed to defend China if attacked.

As a whole, these three agreements succeeded by constraining the construction of capital ships. Unfortunately, the agreements failed to account for Japanese imperial designs, especially toward China. From Tokyo's point of view, Western unwillingness to act decisively in protecting Pacific territories and defending a pathetically weak China from invasion served as a green light for establishing the Greater East Asia Co-prosperity Sphere. As such, the Washington Naval Conference inadvertently facilitated the start of World War II.

Robert S. Hopkins

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Weapons Systems

According to the official dictionary of the U.S. Air Force, a weapons system (WS) is an instrument of combat, such as a bomber or guided missile, together with all related equipment, supporting facilities, and services, required to bring the instrument upon its target or another location.

This explanation, when applied to a single unit of striking power built around an air vehicle such as a fighter airplane, refers not only to the immediately visible components (airframe, power plants, fire-control system, machine guns and/or cannons, missiles, navigation equipment, radar system, rockets, and other devices that are known to be aboard) but also to the entire system; the air vehicle is only the carrier.

The first established weapons system (WS) designation was the one issued to the Boeing B-47 Stratojet as WS-100A/L, which included all of its systems. The "A" suffix meant that the weapons system number (-100A) was for a standard B-47 model bombardment aircraft. The "L" suffix (-100L) denoted that it was a photographic reconnaissance version of the B-47 designated RB-47—the "RB" prefix meaning photographic reconnaissance bomber. The second WS number issued was WS-101A/L, which identified the Boeing B-52 and RB-52 Stratofortress aircraft and all of their respective systems.

Beginning in the early to mid-1950s, then, many WS-numbered designations have been assigned to attack, bomber, fighter, and interceptor aircraft, as well as to strategic missile systems such as the General Dynamics (Convair) SM-65 Atlas—America's first operational ICBM, or WS-107A.

Weapons-system classifications are ongoing; for example, the more recent Boeing North American B-1 B Lancer is WS-139A. A much higher WS-number (WS-464L) identified the Boeing X-20 Dyna-Soar program. (There were no WS-1 through WS-99 designations.)

Steve Pace

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Welch, Larry D. (1934–)

U.S. Air Force general and Chief of Staff. Larry Welch was born on 9 June 1934 in Guymon, Oklahoma, and enlisted in the Kansas National Guard in October 1951. In November 1953, he entered the aviation cadet program, received his pilot's wings and commission as a second lieutenant, and served for a time as a flight instructor. His assignments included a stint as operations officer for the 389th Tactical Fighter Squadron stationed at Phan Rang Air Base in South Vietnam. While in Vietnam he flew combat missions in F-4Cs over North Vietnam, South Vietnam, and Laos. From July 1972 to September 1974, he served as deputy commander for operations, then as vice commander, 35th Tactical Fighter Wing, at George Air Force Base, California. After receiving his first star in 1977, he became inspector general, Tactical Air Command. In November 1982, he went to Headquarters U.S. Air Force in Washington, D.C., as deputy Chief of Staff for programs and resources and in August 1984 became vice Chief of Staff of the U.S. Air Force. From August 1985 to June 1986, he served as commander in chief, Strategic Air Command, and director, Joint Strategic Target Planning Staff, at Offutt Air Force Base, Nebraska. He became chief of Staff of the U.S. Air Force on 1 July 1986.

At the outset of his tenure as chief, General Welch was concerned with the U.S. strategic deterrent force's lack of ability to retaliate promptly against "hardened Soviet nuclear forces" and command-and-control assets. He made the strategic force issue one of his top priorities. He saw the B-1B as a superb bomber that would serve for future years initially as a penetrating bomber and then as a cruise-missile carrier.

When the Soviet Union professed a more open attitude toward the West as expressed by Gorbachev's policies of glasnost and perestroika openness and restructuring, General Welch urged that the United States remain strong in order to continue pressing the Kremlin. He also saw that the federal deficit was becoming a major national concern and that a smaller defense budget could help reduce that deficit.

On 30 June 1990, General Welch retired.

George M. Watson Jr.

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Wells, Edward C. (1910–1986)

Boeing's chief engineer on the B-17 and other U.S. bomber programs. Edward C. Wells was born to a middle-class family in Boise, Idaho. The family moved to Portland, Oregon, where Wells completed high school. He started college at Willamette University and went on to Stanford, where he earned a degree in mechanical engineering in 1931. Wells gained a summer job at Boeing during his junior year in college and permanent employment upon graduation.

At the age of 24 he began work on the Model 299—the B-17 prototype. Complex mechanical systems were his forte. When the airplane became a formal program, Wells became its chief engineer, earning him the title father of the B-17. He was also placed in charge of the B-29 program.

After World War II, Wells headed Boeing's engineering force in developing the B-47, B-52, KC-135, 707, 757, 767, SST, and numerous space programs. He retired in 1972 but remained a member of the board of directors until 1986.

Alwyn T. Lloyd

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Wells, Herbert George (1866–1946)

British author who inspired many aviation pioneers with his sci-fi works. Born in Bromley, Kent, on 21 September 1866, H. G. Wells is most famous for authoring such novels as *The Time Machine* (1895) and *The War of the Worlds* (1898). Although briefly schooled, he was mostly self-taught. Beginning in 1901, he wrote about future technologies in his novels. *The War in the Air* (1908) even contributed to the first round of "Zeppelinitis" in England, where rumored airship incursions caused brief mass hysteria. Wells also wrote editorial pieces on airpower in April 1914, arguing that new technologies, not established strategies, would determine the winner. Wells was not always on the mark: While predicting atomic bombs, he dismissed submarines; he also described World War I as the "war to end all wars." After the conflict, his interests shifted, but his work inspired writers who projected air-war scenarios in the 1940s. Wells survived the London Blitz and died in his sleep on 13 August 1946.

Guillaume de Syon

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Westland Lynx

One of three helicopters types designed for use by the armed forces of Britain and France, the others being the Gazelle and the Puma. All were authorized by a joint agreement signed in February 1967.

Led by Westland, the first development Lynx started flight trials in March 1971. The first in-service use by the Fleet Air Arm began in September 1976, at which time they began to replace the earlier Westland Wasp. A similar deployment program was put in place for the French navy.

The naval Lynx has proven popular with the navies of many overseas countries, serving with Denmark, Germany, Holland, South Korea, and others. A version destined for the Royal Air Force was later cancelled, its place being taken by the more useful Gazelle.

The British army also operates the Lynx in the antitank role, replacing the earlier Westland Scout. The first variant deployed was the AH.1, although subsequent developments have seen the version number rise to the current AH.9 standard.

Each helicopter unit flies a number of Lynx for the attack role; spotting tasks and communications are the province of the Gazelle.

Kev Darling

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Westland Lysander

Forever known as the "Lizzie"—the British plane developed to replace the venerable Hawker Hector biplane in the army cooperation role. The contract was placed in the 1935, the first prototype flying in June 1936. An initial contract for 140 production aircraft was placed in the same year, with service deliveries beginning in 1938.

With the outbreak of hostilities in Europe, five squadrons of Lysanders deployed as part of the air component. Their duties included artillery-spotting and reconnaissance. During these operations, a Lysander succeeded in shooting down a Heinkel He 111 over British Expeditionary Forces territory. When the forces in France suffered their reversal, the air component acted in support of the troops at Dunkirk. Their roles included dropping supplies and attacking German forward positions. The Lysanders of No. 4 Squadron were the last aircraft to return to the United Kingdom.

Overseas the Lysanders based in the Middle East took part in operations in Egypt and Greece before moving on to India. In support of operations in both the Far East and Europe, a special-duties version was produced. It featured an extra external fuel tank and an access ladder fixed to the outside to allow for egress and ingress by special agents.

After the retreat from Dunkirk, the Lysanders based in Britain were temporarily equipped with sponsons on the wheel spats for carrying light bombs. As the RAF received newer aircraft, the duties of the Lysander changed to that of air-sea rescue and target-towing.

The last active-duty Lysanders retired from No. 367 (Special Duties) Squadron in 1945 and was finally declared obsolete in 1946.

Kev Darling

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Wever, Walter (1887–1936)

First chief of Luftwaffe General Staff (1933–1936). Wever was born in Whilelmsort, West Prussia, on 11 November 1887 and died in the crash of his Heinkel He 70. Wever had only recently learned to fly and was a relatively inexperienced pilot for a sophisticated aircraft like the He 70. The cause of the crash was pilot error—he had failed to release the control lock.

Wever entered the German army in 1905 and became a lieutenant in 1906 and a captain on 18 June 1915. After 1918, he spent six months in the War Historical Department of the General Staff and also as an officer in field commands. Promoted to major in 1926, he became a lieutenant colonel on 1 April 1930 and a full colonel on 1 February 1933. He did well in assignments as company commander from 1924 to the beginning of 1927 and as a battalion commander from October 1929 to September 1931. During this time, he held positions in the secret air branch of the Reichswehr ministry. He was chief of the army's training department from 1 March 1932 to 31 August 1933.

On 1 September 1933, he was appointed chief of the Air Command Office, the secret general staff of the still-clandestine Luftwaffe. Like many others, he studied the ideas of Italian airpower pioneer Giulio Douhet. Originally opposed to an air force as an independent service, he sympathized with Hitler's political aim of reestablishing a powerful Germany, including a strong independent bomber force.

Wever grasped the importance of a strategic bomber fleet to deter potential enemies during the German rearmament phase and ordered the development of a four-engine bomber dubbed the "Uralbomber." It was his view that the Soviet Union was a possible adversary, but he did not adopt Douhet's theory of the primacy of the strategic bomber. Aware of Germany's geostrategic position in the center of Europe, he knew that a tactical bomber forcer was needed above all. On 6 May 1936, Wever ordered that the fast medium bomber should have priority over all heavy bomber projects.

Wever was one of the first Reichswehr officers who thought about the combined operation of tanks and aircraft. Under him, the first German paratroop force was created and the dive-bomber introduced. Promoted to one-star general on 1 October 1934 and given the second star a half-year later, Wever did not live long enough to see the fruits of his labors. Had he lived longer, the strategic bomber force might have received priority if political and military conditions had called for it. They could not be pursued simultaneously in strength for material reasons.

Horst H. Boog

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Weyland, Otto P. "Opie"

U.S. Army general; during 36 years of service, he mastered tactical operations as a theorist and as a practitioner. Born in Riverside, California, he graduated from Texas A&M University and entered the U.S. Army Aviation Service in 1923. He spent his early career as a fighter and observation pilot. Named deputy director of air support at USAAF headquarters at the outbreak of World War II, Weyland developed tactics, techniques, and equipment for tactical air operations. In 1943, he went to Europe to lead the 84th Fighter Wing and soon commanded the XIX Tactical Air Command. In the latter position he directed fighter-bombers for Operation OVERLORD and teamed with General George S. Patton to spearhead the breakout from Normandy. Weyland introduced armor-column liaison officers—USAAF fighter pilots who rode with lead tanks (later called forward air controllers). Additionally, he perfected battlefield air-interdiction tactics, permitting airpower to cover Patton's southern flank during the Third Army's drive across France.

In July 1950, Weyland became vice commander for operations of the Far East Air Forces (FEAF), where he coordinated attack efforts to save the United Nations troops hemmed in along the Pusan perimeter. Later he focused USAF efforts to interdict enemy rail and communications lines in the Korean War. In 1951, he became FEAF and UN Air Force commander. He directed the continued interdiction efforts and the air superiority struggles over MiG Alley. Weyland also directed the strategic campaign against the Korean electrical power system and Korean irrigation dams. After the Korean War, he reorganized Japan's air defense and aircraft industry.

After his return to the United States in 1954, Weyland battled for tactical operations in an Air Force dominated by the Strategic Air Command. He became commander of the Tactical Air Command, where he introduced the Composite Air Strike Force and furthered overseas deployment capability. He retired in 1959.

John Farquhar

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White, Thomas Dresser (1901–1965)

U.S. Air Force Chief of Staff. Thomas Dresser White was born on 6 August 1901 in Walker, Minnesota. He attended St. John's Military Academy in Delafield, Wisconsin, from 1914 to 1918. He graduated from the U.S. Military Academy in 1920, one of the youngest graduates in its history. He became interested in airplanes and transferred to the Air Service, earning his wings in 1925. Assigned to Washington, D.C., with the 99th Observation Squadron, he enrolled at Georgetown University to study the Chinese language. He was sent to China in 1927 to continue his language study and was able to convince his superiors to allow him to observe the fighting between Chiang Kai-shek and the communists. The reports that he sent back were so thorough that his superiors allowed him to stay longer. He also began his study of Russian that would serve him well when, after a stint at Air Corps Headquarters in 1931, he was assigned to the Soviet Union as assistant military attaché for air in February 1934.

A series of attaché assignments in Italy, Greece, and Brazil further developed his talents not only as a first-rate intelligence officer but also as an accomplished linguist. During these tours he became fluent in Chinese, Russian, Italian, Greek, Portuguese, and Spanish. Promoted to captain in August 1935, he returned to the United States in May 1938 to attend the Air Corps Tactical School at Maxwell Field, Alabama, and the Army Command and General Staff School at Fort Leavenworth, Kansas.

Following his tour at Fort Leavenworth, he was again assigned staff duty in the office of the chief of the Air Corps. Shortly thereafter, he was promoted to major and sent to Brazil as military attaché. After World War II began, White was recalled to the United States in 1942 to serve as assistant Chief of Staff of Operations and then Chief of Staff of the Third Air Force at Tampa, Florida, whereupon he was promoted to brigadier general. In January 1944, he was reassigned to Army Air Forces Headquarters, where he became assistant Chief of Staff of intelligence. In this post he helped formulate plans for the D-Day invasion.

His request for combat duty was finally honored in September 1944 when he went to the Pacific as deputy commander of the Thirteenth Air Force and took part in the New Guinea, southern Philippines, and Borneo campaigns. In June 1945, White became commanding general of Seventh Air Force in the Marinas and led it in island-hopping to Okinawa, where it played an important role in bringing about the Japanese surrender. Promoted to major general in 1946, he was called to Tokyo as Chief of Staff of the Pacific Air Command. One year later, he assumed command of the Fifth Air Force in Japan.

General White returned to the United States in 1948 to serve as director of USAF legislation and liaison. He was promoted to lieutenant general in 1951, and for more than a decade he held a succession of top-level posts in Headquarters USAF. General Nathan F. Twining selected him as his vice Chief of Staff in 1953. In that position, General White was largely responsible for domestic issues such as the air defense buildup.

When General White replaced General Twining as Chief of Staff of the Air Force in 1957, his major challenge was to interweave a complex array of missiles, space-based systems, and atomic weapons into the nation's arsenal. Believing that the Air Force ought not devote its resources overwhelmingly to a single weapons system, he called for a mixed force of strategic bombers; intercontinental and medium-range ballistic missiles; tactical aircraft; installations and reliable and secure communications; an advanced reconnaissance system; a modernized cargo fleet; and advanced space systems. During his tenure, the Air Force made its initial deep move into space, launching satellites for reconnaissance, weather forecasting, communications, and as space probes.

When he retired in 1961, the National Geographic Society honored him by designating a space award to be given annually in his name. Later, President John F. Kennedy appointed him to the General Advisory Committee of the Arms Control and Disarmament Agency, which was extended by President Lyndon Johnson. Although suffering from the initial stages of leukemia in 1965, he was called upon to chair a special advisory committee appointed by Secretary of the Air Force Eugene M. Zuckert to investigate the cadet honor system and the athletic program at the U.S. Air Force Academy. It was his final mission for the Air Force and his country; he died on 22 December 1965.

George M. Watson Jr.

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Whittle, Frank (1907–1996)

First person to think of the modern aviation gas-turbine engine; recognized as an independent coinventor of the turbojet. He was born to working-class parents in Coventry, England, on 1 June 1907 and entered the Royal Air Force in 1923, graduating from its Aircraft Apprentices Wing in 1926. He also graduated from RAF College–Cranwell in 1928 and from Cambridge University in 1936.

Whittle was fascinated with the idea of aviation gas turbines from an early age and discussed them in his 1928 thesis, "Future Developments in Aircraft Design." He then expanded his original ideas and in 1930 applied for his first gas turbine–related patent, which outlined the concept for the modern turbojet engine. Forming a private company in 1936, Power Jets Ltd., Whittle began running a prototype engine on 12 April 1937. His first flightworthy engine, designated the W.1, took to the sky on 15 May 1941, powering an experimental Gloster E.28/39 aircraft. Whittle's company was nationalized by the British government in 1944, and shareholders were compensated at bargain-basement prices. He retired from the RAF in 1948 with the rank of air commodore and was knighted by King George VI. Whittle then became a consultant. In 1976, he came to the United States and served on the faculty of the U.S. Naval Academy.

Stanley W. Kandebo

See also

Gloster Aircraft; von Ohain, Hans Joachim Pabst

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Wild Weasel

Air-suppression tactic. Over Southeast Asia during the Vietnam War, North Vietnamese radar-guided SA-2 Guideline surface-to-air missiles (SAMs) were a major problem for U.S. fliers. The first SAM downed an F-4C in July 1965, and others followed. Because most of the SAM sites were off-limits in Hanoi and Haiphong Harbor, U.S. aircraft adjusted their tactics, flying beneath detectability by the SAMs. This approach made the planes vulnerable to antiaircraft and small-arms fire and cost 50 Air Force and Navy aircraft. Evasion was but a weak workaround; until aircraft carried their own electronic countermeasures, the solution was the EC-66 and the Wild Weasel.

Brigadier General K. C. Dempster held a seminar that produced the solution with two pieces of equipment. The first was the APR-25 Radar Homing and Warning System, an IR-133 panoramic receiver to analyze the APR-25 signals and determine the origin—antiaircraft, ground-control intercept radar, or SAM site. The second was the APR-26 launch-warning receiver to detect the increased power indicating a SAM launch. Wild Weasel teams included an ace pilot and an equally ace electronic-warfare officer. The first aircraft selected for the task was the North American F-100F, armed with 20mm cannons, 2.75-inch rockets, and later Shrike missiles tuned to home in on the SAMs. The Weasel tactic was to precede the attacking jets by 5 minutes, get the SAM to reveal itself, then attack with missiles and conventional weapons.

The suppression of enemy air defense carried out by the Wild Weasel crews was one of the most important and certainly the most dangerous missions of the Vietnam War. The Republic F-105s had to tank up going in and coming out. (U.S. Air Force)

On 21 November 1965, the first Wild Weasels were at Korat AFB, Thailand. They were the 624th Tactical Fighter Wing (Wild Weasel Detachment) of the 388th Tactical Fighter Wing and were given the mission code-named IRON HAND. Wild Weasels flew in four flights with F-105 escorts, and their motto was "first in—last out." The first year, seven attacks got seven sites with two aircraft lost and five damaged beyond repair.

By 1966, the Weasels upgraded to F-105s. On 20 December, Captains John Pitchford and Robert Trier were in the first Wild Weasel ever to be shot down. The first success came during Operation ROLLING THUNDER with Captains Al Lamb and Jack Donovan as crew members.

The Wild Weasels helped reduce the loss rate of aircraft. In 1965, 11 aircraft were lost to 194 SAMs; by 1972 49 were lost to 4,244 SAMs, a decline in the SAM success rate from 5.7 percent to 1.15 percent. After 1966, U.S. aircraft had their own electronic countermeasures, but the Wild Weasel and EC-66 continued to play a role.

John Barnhill

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Williams, Robert R. (1918–)

U.S. Army Lieutenant general. Born in Evanston, Wyoming, he graduated from West Point in 1940 and entered the field artillery. Lieutenant Colonel William W. Ford selected

Williams, a private pilot since 1935, to be his operations officer when organizing the test detachment for organic aviation in the field artillery in December 1941. During the next 33 years, Williams was at the forefront of efforts to make the greatest possible use of organic air in the Army.

As a member of the air staff (December 1944–December 1945), Williams was one of the coauthors of a series of reports on the effectiveness of field artillery aircraft in combat, essential events in the 1945 decision to expand the program to the other ground combat arms. In the 1940s and 1950s, he was a central figure in an informal group of midlevel Army officers who were convinced that the Army was not exploiting its aerial vehicles to their full potential and who worked behind the scenes to make it so. He played a key role in the establishment of the so-called Howze Board and the implementation of its recommendations. Williams was responsible for the testing and evaluation of the Army's first airmobile division (August 1963–June 1965). Other important assignments included commander and commandant of the Army Aviation Center and School (1961–1963), the director of aviation on the Army staff (1966–1967), commander of the 1st Aviation Brigade in South Vietnam (1967–1968), and assistant Chief of Staff for force development on the Army staff (1970–1972). After retiring in 1974, he became president of Bell Helicopter International.

Williams had greater cumulative impact upon the scope and purpose of Army aviation during its first 30 years than any other individual.

Edgar F. Raines Jr.

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Wind Tunnels

Research and design tools used extensively in the aircraft and missile industries. Wind tunnels can save many hours of flight-testing and are a vital resource when investigating transonic and supersonic performance. They are used to gather aerodynamic data, to perform flutter testing, and for airflow and shockwave visualization to determine where the airflow separates from a smooth flow around the test model.

Most wind tunnels are subsonic, built as a closed, sectioned, tubular structure with a fan or propeller to produce airflow. A scale model of an aircraft or missile is placed in a narrow working section, and air enters through a constriction that increases the speed of the airflow in the working section and makes it more uniform. Calibrated balances measure the lift, drag, and side forces and the rolling, pitching, and yawing movements experienced by the model under test.

High-speed (transonic and supersonic) wind tunnels usually require a reservoir of compressed air to provide the motive power. The air is allowed to blow through a convergent-divergent nozzle to create a supersonic flow, then through the (typically very small) working section, and finally exhausts into the atmosphere. Clearly, high-speed tunnels can run at a constant speed only for a very short period of time, but Mach numbers of 4 or more can be reached.

Historically, supersonic wind tunnels have encountered difficulty as the airspeed approaches the speed of sound, as the airflow through the working section tends to be choked by the formation of unwanted shockwaves. This is particularly difficult to overcome at transonic speeds (Mach 0.85–Mach 1.1). Supersonic wind tunnels were available well before transonic tunnels, and many early jet aircraft experienced difficulty in the transonic region because of lack of reliable experimental data.

Andy Blackburn

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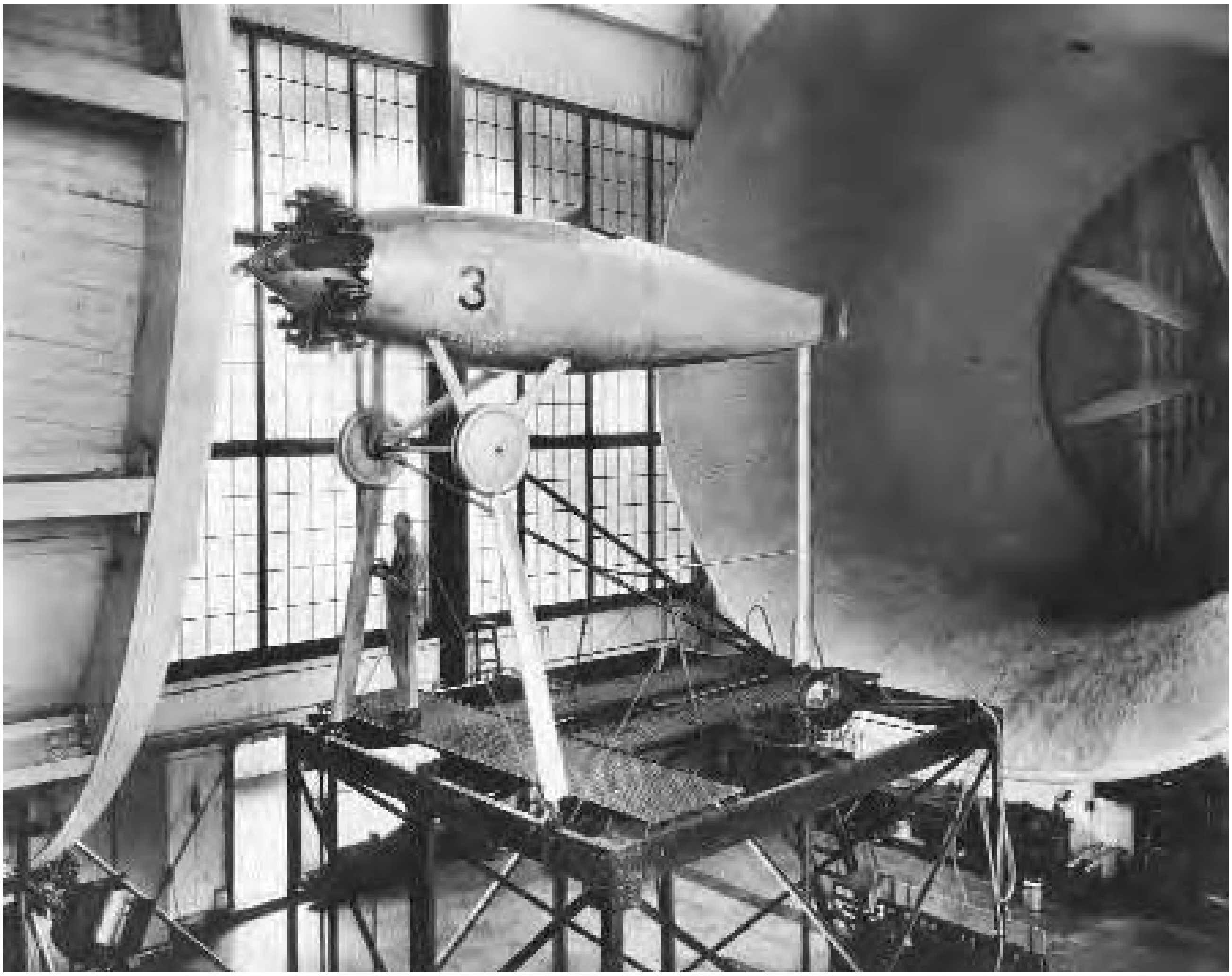
Winter War (1939–1940)

The Soviet-Finnish conflict in the winter of 1939–1940, mostly over strategically important territories of the Karelian Isthmus. The air operations demonstrated the abilities and constraints of airpower in action in severe weather and over difficult and heavily wooded terrain. At the outbreak of hostilities, the Soviet air force had assembled about 900 aircraft, expecting an easy and quick campaign. Then Finnish air force had 162 mostly obsolete aircraft of all types.

Enjoying permanent air superiority in the course of the war, the Red Air Force was able to secure vulnerable rear areas from air strikes but failed to eliminate in a surprise strike the dispersed Finnish combat aircraft on the ground. Soviet airpower was engaged primarily in close support, air cover, and airlifting of assaulting troops in the Karelian Isthmus, some limited air operations in the Arctic area, as well as bombing raids on more than 160 rear targets.

Despite large-scale employment of bombers in daytime



The large wind tunnel at Langley proved to be invaluable in refining aircraft design. (NASA)

and clear-weather raids, the Soviets were unable to undermine Finnish defenses, economic life, supply traffic, and morale. This was due to wintertime navigation problems, bombing inaccuracy, and the fierce Finnish air defense, which claimed 275–314 Soviet air losses (more than half of them bombers).

The Finns also used fighters energetically and adapted to winter conditions: They equipped fighters with skis for takeoffs and landings on ice and snow. Their pilots demonstrated a higher level of combat skills compared to the Russian pilots. During the war, Finland received 240 aircraft of all types as well as volunteer pilots from Western countries, but massive aid was compromised by politics and logistical difficulties.

The Soviets massed reinforcements (1,500–2,000 planes) in January-February 1940 and introduced some operational and tactical changes (nighttime and poor-weather bombing raids as well as fighter escorts). Nevertheless, the war was won by the Soviets mostly on the ground due to the dramatic disparity of forces involved. Moreover, the evident failure of the Soviet air campaign was one of the primary reasons the war went on for as long as it did. The total Russian war losses were 594 aircraft; the Finnish air force lost 62 planes from all causes.

Peter Rainow

See also

Bristol Aircraft; Finland, and Air Operations During the "Continuation War"; Finnish Air Force (Early Years); Fokker Aircraft (Post-World War II); Polikarpov, Nikolai N.; Smushkevich, Yakov "General Douglas"; Soviet Air Force; Tupolev

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Women Airforce Service Pilots

The female component of the U.S. air forces, known as the WASPs. Three years before the United States entered World War II, one of America's prominent women pilots, Jacqueline Cochran, suggested that women pilots could serve in noncombat flying roles to free men for emergency war-preparedness duty. Because there was no pressing manpower problem, the Army demurred.

By 1942, however, the supply of aviation cadets could not meet demand. In September 1942, President Franklin D. Roosevelt appointed Cochran director of the Woman's Flying Training Detachment (WFTD). Cochran's job was to supervise and coordinate the training of women pilots for assignment to the Women's Auxiliary Ferrying Squadron (WAFS) of the Air Transport Command. WAFS's job was to ferry new fighters and bombers to air bases throughout the United States. In 1943, the WFTD merged with WAFS to form the Women's Airforce Service Pilots (WASP), with Cochran as director and Nancy Love as executive commander.

By 1944, combat losses were below predictions, and large numbers of USAAF pilots were rotating home to take over stateside duties. General Henry H. "Hap" Arnold, who had gone on record that "women can fly as well as men," announced the WASP program would end on 20 December 1944. WASPs were summarily sent home without military benefits. However, on 23 November 1977 President Jimmy Carter signed legislation giving the WASPs veterans' benefits—more than 30 years after they had been disbanded.

WASPs delivered 12,650 planes of 77 different types. They ferried more than 50 percent of all the high-speed pursuit planes. More than 25,000 women applied to WASP; of the 1,830 women admitted, 1,074 graduated. They flew more than 60 million miles; 38 lost their lives in accidents.

Henry M. Holden

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Women in Air Combat

Only since the 1990s have women consistently been allowed to serve in direct air combat roles in most Western militaries. Though women flew in a variety of noncombat capacities in the United States and other nations during World War II, and even in three air combat wings in the Soviet Union, in postwar years these practices were sharply curtailed.

The U.S. military, by virtue of its size and prestige, has in recent decades played the most influential role in opening doors to women in air combat. The process began in 1973 with the transition to an all-volunteer force and its attendant increase in demand for qualified personnel. That same year, for the first time six women earned the status of naval aviator, followed shortly by women earning their wings in the Army (1974) and the Air Force (1977). Though after 1976 women were allowed into the three U.S. military academies, their continued restriction to noncombat roles remained a serious career obstacle. By the 1980s, it had become increasingly clear that U.S. women were already participating in missions that involved combat in all but name, holding the lives of millions in their hands as ICBM launch-control officers, and coming under fire as helicopter pilots during the 1989 invasion of Panama.

The 1990–1991 Gulf War demonstrated to the American public how integral women had become to U.S. airpower. They loaded laser-guided bombs onto F-117s, directed from AWACS aircraft F-15s as they intercepted and destroyed Iraqi MiG-29s, commanded Patriot missile batteries as they engaged incoming SCUD missiles, and flew refueling and supply aircraft, often deep into Iraqi airspace. Two women were taken as prisoners of war, including Major Rhonda Cornum, a flight surgeon on a Black Hawk helicopter downed while attempting the rescue of a fellow pilot behind enemy lines. Thirteen women were killed during Operation DESERT STORM, including a Chinook helicopter pilot, Major Marie T. Rossi, even though women were restricted to noncombat roles.

Entering the post–Gulf War era, the final frontier for women in air combat was fighter and bomber aircraft. In 1988, Canada quietly led the way when two women joined operational CF-18 squadrons for the first time. In December 1991, all U.S. legal impediments to women flying combat missions were removed, but the various services succeeded in delaying a final decision until the 1992 election. The Bill Clinton administration, under pressure from the unfolding Tailhook scandal, finally settled the matter on 28 April 1993 when Defense Secretary Les Aspin announced that virtually all remaining restrictions on women pilots were lifted. By 2000, U.S. women pilots were fully integrated into their respective services, having flown numerous combat missions over Iraq and the former Yugoslavia. Women pilots today fly in the armed forces of pioneering nations like the United States, Canada, and Denmark and in many other Western air forces as well.

David Rezelman

See also

Gulf War; Soviet Women's Combat Wings; Women Airforce Service Pilots (WASP); Women in the Air Force; Women's Auxiliary Air Force; Women's Auxiliary Ferrying Squadron

The first all-female aircrew of the U.S. Air Force. (U.S. Air Force)

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Women in the Air Force (WAF)

Between 1948 and 1976, the U.S. services were gender-defined. There were Women Marines, WAVES (Navy), WAC (Army), and WAF, Army Air Force, Air Force). Women had served in the military nurse's corps from 1902; thousands flew during World War II in the nonmilitary Women's Auxiliary Ferrying Squadron (WAFS) and the Women's Airforce Service Pilots (WASP). Under the defense reorganization of 1948, the services began accepting women with restrictions: no more than 2 percent of the force; highest rank would be colonel; many career fields would be off-limits, including flying and combat. Over the next two decades, the Air Force had difficulty filling even its 2 percent ceiling, averaging just more than 1 percent during that time; by the mid-1960s, fields that had been open in the 1940s and 1950s were closed to women.

Colonel Jeanne M. Holm took over WAF in 1965, doubling its size, modernizing uniforms, and expanding career opportunities. She became the first female Air Force brigadier (1971) and major general (1973). Women's rights grew in the 1970s. Women entered the ROTC in 1972, the Air Force Academy in 1976. Seven percent of the veterans of DESERT STORM are women; by the mid-1990s, women competed for 99 percent of Air Force slots, excluding only direct combat.

John Barnhill

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Women in the Aircraft Industry (World War II)

During World War II, women worked in the aircraft industries of each of the major combatants. Though Nazi propaganda prevented the mass employment of German women until late in the war, Germany did force women drawn from throughout the occupied territories of Europe to work in wartime industries. In Japan, traditional restrictions on the role of women were relaxed as war fortunes waned, and by 1944 millions of women and even schoolgirls were working to produce war material. Probably no nation so nearly approached the "total war" ideal of mobilizing an entire society as did the Soviet Union; many women were integrated into the aircraft industry, just as they were integrated into almost every facet of the Soviet war effort. In Britain, women were already present in the prewar workforce in large numbers, but the nature of their employment was dramatically altered by the war. From 1939 to 1943, the number of women working in wartime manufacturing increased by 1.5 million; statistically these women were older and far more likely to be married. Changes in the area of aircraft motor production and repair were typical for engineering as a whole, with the number of women workers growing from less than one in 10 before the war to more than one in three by 1943.

It was in the United States, however, that the image of the wartime female worker would become the most famous, exemplified by the popular propaganda figure Rosie the Riveter. Women had worked in the U.S. aircraft industry since at least the 1920s, but during World War II their numbers rose dramatically. According to one survey, the number of women in the aircraft industry increased from 143 in April 1941 to 65,000 in October 1942. By 1944, approximately 40 percent of workers in Los Angeles–area aircraft plants were women, a percentage typical for the nation as a whole. Images of women defense workers abounded: Popular movies of 1943 included *Swing Shift Maisie* and Ginger Rogers's *Tender Comrade,* both set in aircraft factories; songs of the era in-

"Rosie the Riveter" symbolized the dedication of women to the war effort. Employers were agreeably surprised to find that women not only did as well as male workers, they often did better. (U.S. Air Force)

cluded "The Lady at Lockheed" and "We're the Janes Who Make Planes." Perhaps the best example of all this is the song "Rosie the Riveter" (written in 1942 by Redd Evans and John Jacob Loeb and popularized the following year by the Four Vagabonds): "Keeps a sharp lookout for sabotage, sitting up there on the fuselage, that little girl can do more than a male can do, Rosie the Riveter."

These popular images have led to some misconceptions and exaggerations, however. The majority of American women during the war stayed at home, and wartime factories usually employed more men than women. Among those women who did join the industrial workforce, fewer than 10 percent had husbands in the service; as in Britain, about half of women defense workers had already been in the national workforce for years—it was just that now they were allowed into occupations formerly reserved for men. Wartime pressures resulted in the breaking of racial barriers as well as sexual ones, as this period saw tremendous increases in the number of African American and Hispanic women participating in defense industries. Still, it was the massive success of the Rosie the Riveter campaign that has had the most lasting impact, and it is the image of the white former homemaker that is most firmly planted in American historical memory.

Women working in defense industries faced a variety of obstacles. One in three had children at home under the age of 14, yet formal child care programs were rare. Though the amount of money women could make often increased dramatically compared to prewar jobs, they were often paid far less than the men working alongside them. In theory, racial discrimination was prohibited in all defense industries by President Franklin D. Roosevelt's 1941 Executive Order 8802, but in practice African Americans were often given the most menial jobs available—or even rejected outright by potential employers. The majority of women workers polled in 1944 planned to continue working after the end of the war, and partly as a result of this government and corporate ad campaigns of this time increasingly emphasized the importance of women returning to the home at war's end. The massive postwar defense industry layoffs hit women especially hard; in the Los Angeles area, for example, the proportion of aircraft work being done by women fell from its wartime high of 40 percent to 18 percent by 1946 and 12 percent by 1948.

Despite these problems, in retrospect the glass was probably at least half-full for the some 300,000 American women that worked in the aircraft industry during World War II. Postwar attempts to return Rosie to her happy home were only partially successful. By the early 1950s, the percentage of women working in the Los Angeles–area aircraft industry had rebounded back to 25 percent. Although most Rosies did return home in postwar years, their outlook was forever broadened, and the wartime experiences of these women played an important if hard to quantify role in generating the discontent of the 1950s that manifested itself in the feminist movements of the 1960s and 1970s. Not surprisingly, women workers in World War II have received much historical attention in the last few decades, both scholarly and popular. Of particular note is the Rosie the Riveter Revisited oral history project, conducted by Sherna Berger Gluck in the Los Angeles area in the early 1980s, and the creation in October 2000 of the Rosie the Riveter World War II Home Front National Historical Park in Richmond, California.

David Rezelman

See also

Soviet Women Pilots; Soviet Women's Combat Wings; Women Airforce Service Pilots; Women in Air Combat; Women in the Air Force; Women's Auxiliary Air Force; Women's Auxiliary Ferrying Squadron; World War II Aviation

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Women's Auxiliary Air Force

The women's auxiliary component of the British air forces. On 1 April 1918, the Royal Air Force combined the Royal Naval Air Service and the Royal Flying Corps. At the same time, the Women's Royal Air Force (WRAF) formed with recruits from the other women's services. For the rest of the war, 9,000 women drove, cooked, clerked, and filled other support roles. After the war, the WRAF disbanded. In the interwar years an alumni association remained active.

In the summer of 1939, the Women's Auxiliary Air Force (WAAF) came into being. As in World War I, women served alongside the men. With some 1,700 members at the outbreak of war, the WAAF grew to roughly 180,000 by 1943. WAAF jobs included catering, meteorology, transport, telephony and telegraphy, codes and ciphers, intelligence, and security. WAAF members were among the 1,570 ground crews who lost their lives.

The WAAF reformed into the WRAF in 1949 and fully integrated into the RAF in 1994. Women are not part of the regular fighting force but do train in the use of weapons for defense. Women are loadmasters, and they pilot transports as well as single-seat and two-seat jet aircraft. Although restrictions remain, most women do the same work as men, attend the same schools, and compete equally for promotion.

John Barnhill

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Women's Auxiliary Ferrying Squadron

The women's auxiliary component of the U.S. air forces formed during World War II. When war broke out in Europe in 1939, two notable women aviators, Jacqueline Cochran and Nancy Harkness Love, proposed separate military flight-training programs. Love proposed using women pilots holding commercial licenses to fly noncombat flying positions in the United States to deliver or ferry military aircraft. Cochran proposed a military flight-training program for women holding private pilot licenses.

In 1942, when manpower requirements became critical, both plans were implemented. Love was put in charge of the Women's Auxiliary Ferrying Squadron, Cochran the Women's Flying Training Detachment. After some advanced training, Love's group began ferrying fighters and bombers from factories to bases throughout the United States. Cochran's group trained at Sweetwater, Texas, completely segregated from male training groups.

In September 1943, the two groups were merged into the Women Airforce Service Pilots—the famous WASPs. Cochran remained in charge of the training program and Love the ferry squadron. WASP was disbanded on 20 December 1944.

Henry M. Holden

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Worden, Hector (1885–1916)

The first pilot of Native American ancestry. Hector Worden was born in White Plains, New York, on 4 February 1885. He worked with John Les Clark of the Indian Exhibit Company and always retained an admiration and interest in his Cherokee ancestry. In the spring of 1911, Worden enrolled in Blériot's aviation school in Pau, France; after crashing his plane he left without a license, unable to pay the damages. He obtained his license on 14 November 1911 upon returning to America. Worden often flew exhibition flights with the Moisant school but found his true calling in military aviation, becoming the first aviator to participate in warfare in the Western Hemisphere.

In 1911, Francisco I. Madero commissioned Worden a captain in his Mexican army to fly reconnaissance and bombing missions against the revolutionaries in Mexico. He served under General Victoriano Huerta for two years. Worden's success encouraged the Mexican government to send three army officers to the Moisant school on Mineola, Long Island, for training in 1912. Worden died on 5 May 1916 from injuries suffered in a crash while attempting to loop-the-loop.

Wendy Coble

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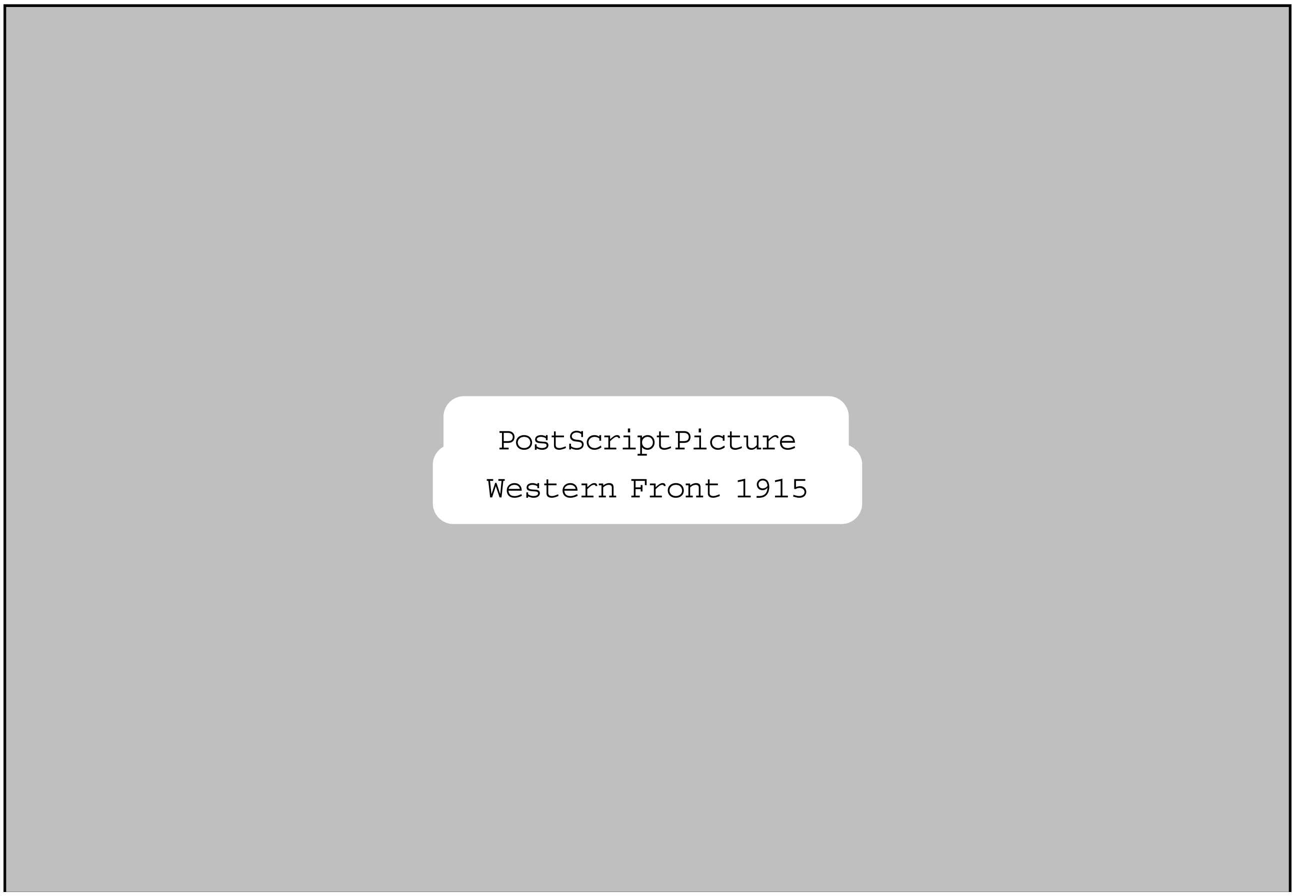
World War I Aviation

Prior to the outbreak of World War I, France, Germany, and Great Britain had each thought about the role that aviation would play in their strategy. Airplanes had participated in prewar practice maneuvers; based on the performances, each power concluded that if the airplane had any value it would be for reconnaissance. They were quickly proven right. On the Western Front, a French aircraft spotted the critical turn of the German army that allowed troops to be rushed forward to what would become the First Battle of the Marne, thereby setting up the race to the sea, the end of the war of movement, and the beginning of trench warfare. Along the Eastern Front, aircraft proved equally significant, giving the Germans the first report of oncoming Russian forces, allowing them to prepare the plan for the Battle of Tannenburg, later prompting Hindenburg to say that without the airplane there would have been no Tannenburg.

Reconnaissance

Once fighting settled into the trenches, aerial reconnaissance began to specialize. Eventually, three branches developed. The first, *strategic reconnaissance,* consisted of continuously photographing enemy territory, interpreting the photographs for their intelligence value, issuing prints to local commands, and printing maps based on the photos. As this branch developed, it was responsible for introducing



several new pieces of technology. The serial camera, which automatically clicked off exposures as the aircraft flew in a straight line over the target in order to facilitate mapmaking, represented a major development in the art of aerial espionage. And as it became necessary to fly higher to avoid hostile defense measures, other bits of new equipment were perfected. Thus were seen the first use of breathing oxygen and heated flight suits to protect the crews from the physical dangers of operating at high altitude. The development of engine superchargers improved overall performance.

The second area, *tactical reconnaissance,* included flying over the enemy during periods of active fighting to report movements and the location of friendly troops. This activity was particularly important given the state of communications technology during World War I. During periods of inactivity, a commander could keep in touch with his troops by telephone. The state of the art, however, was a huge complex of wires connected by telephone exchanges. This system broke down instantly once an attack was under way and troops began to move from friendly territory onto enemy-occupied ground that had been wired for communications. In the absence of wireless communications, troops were located by aircraft, the information being forwarded by one-way radio transmitters, signal lamps, pigeons, or weighted message bags dropped over the local command post. Troops were equipped with signal panels—white strips of cloth that were supposed to be laid out at the most forward position for the airmen to see. This seldom worked, however, as troops were reluctant to lay the panels out for fear of alerting enemy aircraft. As a result, aircrews on contact patrol were forced to fly low enough to distinguish the color of uniforms—a risky proposition because troops on both sides tended to fire on any enemy aircraft they saw.

The third area, *artillery-spotting,* was the regulation and correction of fire by aircraft observing the fall of shot and reporting the results to friendly artillery batteries. One important difference between this and other forms of aerial reconnaissance was that performance was not limited to airplanes. In fact, throughout the war most artillery-spotting was still done by putting someone at the top of a hill overlooking the area to be shelled. Because the German army controlled the majority of high ground for most of the war, however, the Allied nations were forced to use aircraft for a great deal of this work. This included airplanes as well as tethered observation balloons.

The two big advantages balloons offered over heavier-than-aircraft when it came to spotting for the guns were duration and ease of communications. Balloons could remain aloft for hours, even all day, working with one or more batteries. Communicating from the balloon basket was far easier than from the rear seat of an airplane, as the balloon observer could be connected directly to artillery commanders by telephone.

Bombardment

Aerial bombing in World War I was primarily tactical: Favorite targets were troop and supply concentrations, railyards and stations, and munitions dumps within easy reach of the front. Strategic bombing had been the subject of theory, but early experiments in its practical application were largely beyond the state of the technological art in World War I. Because of the relatively small lifting power of even the most robust aircraft engines, bombloads and striking range were miniscule by World War II standards. Zeppelins, which promised a great deal in this area at the outset of war due to their extended range, proved a disappointment. The primitive state of aerial navigation often led to airships becoming lost in their search for targets in Britain and dropping their bombs over open fields or on relatively unimportant buildings. And as the war progressed, the development of more effective defensive measures (better antiaircraft guns, fighters with increased ceilings and speeds, and incendiary ammunition capable of setting the large gas bags on fire) forced the Zeppelins to operate at increasingly higher altitudes where precision bombing became even more challenging as crew performance decreased with oxygen deprivation and subzero temperatures.

Air-to-Air Combat

Fighters have dominated the attention of historians for decades. But it needs to be remembered that the development of the fighter was a purely *defensive* measure. Judged in isolation, the dogfight in which a Triplane bested a Camel or vice versa had little objective military value or purpose. They were necessary not to fight each other but to eliminate the reconnaissance aircraft and, to a lesser extent, the bombers that threatened ground operations. Their value during the war as a diversion from the horrors of the trenches and as a morale builder to inspire the home front; during the interwar years the allure of fighters enticed new recruits into the cockpits for World War II; and in the years since fighters have lured fledgling historians into the study

One of the last fighter planes developed for World War I, the Fokker D.VIII saw limited service. (U.S. Air Force) of this fascinating field. Their bravery in the cockpit and long-lasting historical influence cannot be underestimated.

Ground Attack

Ground attack operations developed late, not coming into general use until the spring of 1917, a year too late for the Battle of Verdun. Had the Germans attacked the single Verdun supply route—the Sacred Way—from the air in full force, aviation might have had a war winning impact on the outcome of the conflict. But this conclusion, like many others, reflects nothing more than the newborn status of military aviation in World War I. The better understanding of the uses of airpower that could have led the Verdun commanders to this realization would not come along for another generation.

Naval Operations

The use of aircraft in connection with naval operations centered on reconnaissance tasks, especially scouting patrols for submarines. Aircraft flying ahead of Allied convoys in the last years of the war saved countless tonnage from destruction by German U-Boats. This work led to the development of the so-called Spider Web, an organized network of imaginary grids laid over the North Sea between which aircraft routinely patrolled.

It's fair to conclude that the birth and adolescence of airpower between 1914 and 1918 brought fundamental changes to the conduct of war, changes that would not be fully appreciated or developed until the conflict renewed in 1939.

James Streckfuss

See also

German Air Force (Luftwaffe); Royal Flying Corps/Royal Naval Air Service/Royal Air Force; U.S. Aircraft Development and Production (World War I)

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World War II Aviation

Although it cannot be said that airpower won World War II, it is fair to state that airpower made possible and accelerated the Allies' victory over the Axis powers. If airpower had been removed entirely from the equation, it is possible that the end result might have been exactly the same; given the difference in resources between the Allies and the Axis, however, it is fairly certain that the war would have lasted much longer with much greater loss of life. Airpower proved to be the great advantage of the Allies.

Summary of the Air War: Timing, Technology, Scale

One of the ironies is that the Axis nations chose airpower as a tool for aggression, but the Allied nations made better and far more extensive use of airpower to achieve final victory. The reason for this turnabout was that airpower in World War II turned entirely on three major issues: timing, technology, and scale. The Allies were able to exploit these issues to a far greater degree.

In the beginning, the Axis powers made excellent use of timing and technology. The timing of the war was almost solely of their choosing, and they chose to strike when their air forces were at the peak of modernization, equipped with first-rate aircraft in numbers deemed necessary for victory. Italy has been left out of this equation because its military services were totally unprepared for modern warfare in equipment, training, and morale. It was Italy's misfortune to have a leader, Benito Mussolini, who was so greedy for the spoils of war that he ignored Italy's blatant military deficiencies. In doing so, he sacrificed many brave and capable soldiers, sailors, and airmen.

Democratic Allied powers, because they were democracies, found themselves in a typical position: unprepared for war because politicians had refused to risk electoral defeat by voting to raise taxes necessary for defense. In the Soviet Union—an accidental Ally as a result of the German invasion—the situation was different. Great sums had been spent on the military, including the Soviet air force, but the armed forces were paralyzed with fear as a result of Stalin's insane purges. They left the military bereft of leadership, with the great majority of senior officers executed, the remainder afraid to take any action for fear of arrest and a quick death.

Germany and Japan were thus able to prepare first-class air forces, equipped with the most modern equipment and sufficiently strong to win almost all of their initial objectives. Both nations considered an air force of 3,000–5,000 aircraft, flown by well-trained, well-motivated crews, to be sufficient for their purposes. When Germany initiated the war on 1 September 1939, and when Japan entered the war on 7 December 1941, both nations had bent timing and technology to their will.

However, neither nation had any concept of the scale of effort that airpower required. As a result, their production would soon lag behind that of the Allies. When they finally perceived the scale of the task at hand, they were in no position to achieve it.

Only two nations did. The Soviet Union was one, and it formulated airpower projections in the same way it created divisions and employed infantry, artillery, and tanks: on a grand scale—far beyond the concepts of either the German or the Japanese leaders. In fact, even when properly informed of the scale of the Soviet effort, German leaders refused to believe it.

Even more remarkable was the Soviet ability to relocate the aircraft industry from European Russia to behind the Urals. There they not only instituted mass production in amazingly short order but also introduced new and more effective types of aircraft. It was a magnificent effort, totally beyond the comprehension of the Nazi leaders, Adolf Hitler in particular. In terms of industrial miracles, the Soviet effort corresponded fully to the renaissance of the U.S. aviation industry during the war.

The United States was the other nation to correctly estimate the scale of effort that would be required. The fact that it did so was improbable, as was the method by which grandiose estimates were made and accepted.

The United States, nurtured in its isolation by two oceans and still resenting the events in Europe and Asia following World War I, had let its armed forces be reduced to a bare minimum. In January 1939, the U.S. air forces had a nominal strength of some 1,700 aircraft, 1,000 officers, and 18,000 enlisted personnel. Most of the aircraft were obsolescent, and none were equivalent to their European and Asian counterparts. Only one year later, President Franklin D. Roosevelt would call on Congress to permit the building of 50,000 aircraft per year. It seemed an impossible assignment, but it was the clarion call that brought forth the plan conceived by four brilliant young officers: Lieutenant Colonels Harold Lee George and Kenneth N. Walker and Majors Haywood S. Hansell and Laurence S. Kuter. These four men—all future general officers—created the plan for U.S. airpower in World War II during nine hectic days in August 1941. Their audacious plan—AWPD-1—would prove to be uncannily accurate in concept and fulfillment.

In large part this was due to the permissive and aggressive leadership of the U.S. air forces, personified by Major General Henry H. "Hap" Arnold and Brigadier General Carl A. "Tooey" Spaatz, backed up by the president of the United States. In stark contrast, the Luftwaffe was under the command of a dissolute dilettante: *Reichsmarschall* Herman Goering, who had selected a fellow dilettante, *Generaloberst* Ernst Udet, to supervise the technical development of the service. The chief of state, Hitler, was too preoccupied with the army to do more than treat the Luftwaffe with benign neglect.

AWPD-1 was subsequently modified, but not to a significant extent. The final plan called for 207 groups of aircraft, 68,416 operational aircraft (including 3,740 Consolidated B-36 bombers, a design that was still on the drafting boards). The officer force was to be expanded to 179,398 while enlisted personnel would number almost 2 million. Monthly attrition was estimated at 2,133 aircraft—more than existed in the entire USAAF at the time. Also included were requirements for training, factories, targets, sorties, fuel, bombs, and all the other materiel that an air force of almost 70,000 aircraft would require.

At any other previous moment in history, the tender of such an extravagant plan would have been considered insane. It would have been rejected forthwith, and the careers of the men who made it would have been over. But the planners' timing was impeccable. As grand as it was, their plan was accepted on its merits and implemented with blinding speed. In 1939 in the United States, annual aircraft production of all types had barely reached 3,000, mostly small, simple aircraft. By 1944, the United States was producing aircraft at the rate of 100,000 per year, including some of the largest and most sophisticated aircraft in history. When the war ended, the United States Army Air Forces possessed some 70,000 operational aircraft and had suffered almost exactly the predicted rate of attrition.

In stark contrast, the Axis powers had based their plans on a series of short wars quickly won by the superior technology and numbers of their aircraft working in coopera-

In spite of strong support by Hermann Goering (seen here with Hans Joeschennek), the German Luftwaffe failed to live up to expectations. (Smithsonian Institution)

tion with land and naval forces. A production level of 3,000–5,000 aircraft per year was considered adequate in both nations. When the war grew long, both Germany and Japan made valiant and determined efforts to expand aircraft production. Both succeeded to a remarkable degree, with Germany manufacturing some 40,000 aircraft in 1944, at the height of the Allied bombing raids. In the same year, Japan manufactured 24,000 aircraft, approximately six times its 1939 figure. If the leaders of the two nations had the foresight to make such an effort in 1939 and 1940 rather than in 1943 and 1944, the war might have taken a very different turn.

However, timing now worked against them. They were locked into manufacturing aircraft types that had begun the war and were largely obsolete by 1943. Both nations would introduce new and improved models, including such radical advances as the Messerschmitt Me 262 and Arado Ar 234 jets. These would prove too little, too late.

The Allies reflected the mirror image. Although the Allied forces suffered early defeats in every theater, they endured and were then able to begin large-scale production of more modern types. Thus, in Great Britain the late-model Supermarine Spitfire was supplemented by Hawker Typhoon and Tempest aircraft, and the RAF bomber force moved quickly from twin-engine bombers to the superb four-engine Avro Lancaster and the sensational twin-engine de Havilland Mosquito multirole fighter-bomber. In the United States, production saw multiple modified versions of the Boeing B-17 and Consolidated B-24 bombers, complemented by the introduction of the B-29—the best bomber of the war. Fighter production was originally concentrated on the obsolescent Curtiss P-40, soon replaced by the Lockheed P-38, Republic P-47, and the best U.S. fighter of the war, the North American P-51.

The forced draft of the war effort stoked the fires of technology in all the combatant countries, especially Great Britain, Germany, and the United States. Such technological advances as airborne radar, electronic counterwarfare methods, pressurized cabins, advanced fire-control systems, and jet engines were found in all three countries. Germany, in desperation, leaped ahead in some areas, including rocket and missile technology. Japan lagged behind in almost all areas, for its economy was incapable of expanding production while also conducting extensive research in new disciplines. The Soviet Union lagged as well, but primarily because it was concentrating on the basic weapons necessary to defeat Nazi Germany in the ground war. When the time came—particularly after the acquisition of German engineering data—Soviet technology moved rapidly ahead.

By 1944, timing and technology had turned against the aggressor nations on a scale the likes of which the world had never seen. Japan and Germany reacted like typical militaristic dictatorships: They allowed the discrepancy between their forfeited airpower and the overwhelming airpower to be made up by the blood of their people—soldiers as well as civilians. Axis leaders knew there was no way to win this war, their powerful opponents now fully armed and growing stronger every day, yet they forced their populations to fight on to the very end. In Germany that end came when Allied forces met their Soviet counterparts on the River Elbe. In Japan that end came with the union of the B-29 and the atomic bomb. This combination represented, for the first time, absolute airpower, and the destruction of Hiroshima and Nagasaki finally forced even the Japanese militarists to realize the war was lost.

The following contains year-by-year summaries of air warfare in World War II:

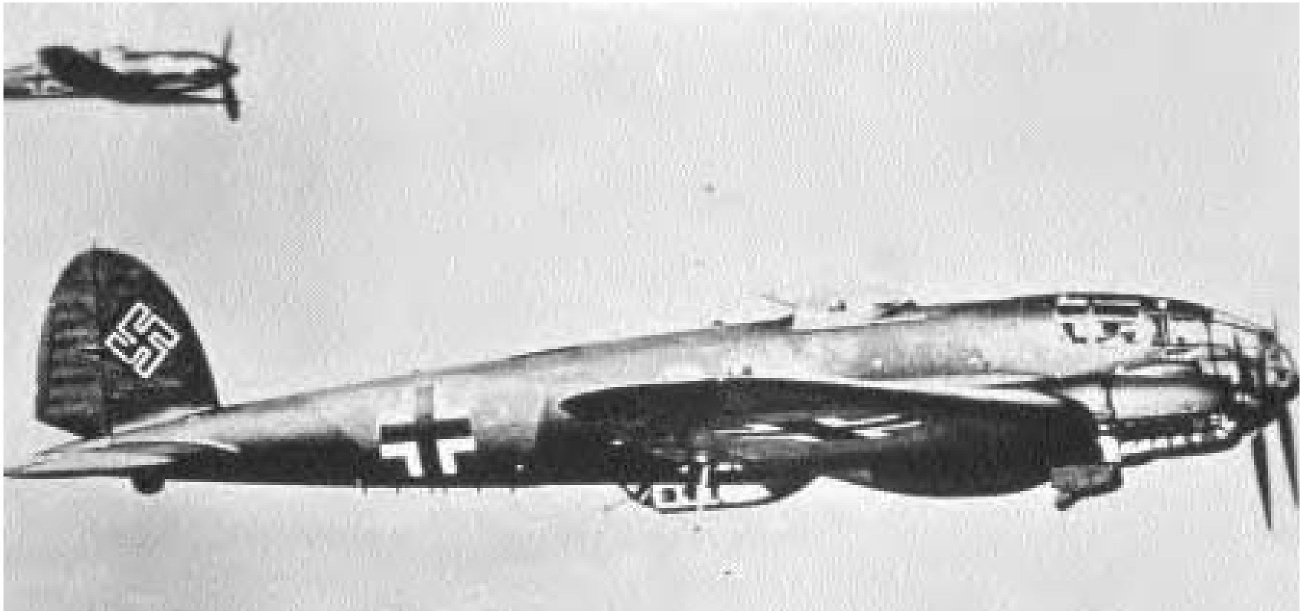
1939

The Luftwaffe paved the way for Germany's victory over Poland, demonstrating blitzkrieg tactics in which aircraft and armor cooperated to penetrate enemy positions. The Allies remained cautious and inactive on the Western Front: The few bombing raids that they did conduct met with failure, and a great deal of effort was expended on utterly pointless leaflet drops. The Germans were careful not to antagonize the Allies at first, in the hope that the war could be ended quickly. In November, the Soviet Union invaded Finland. The Finns resisted valiantly, and their small air force took a heavy toll of Soviet aircraft. In Asia, the Japanese air forces continued to operate over China with little opposition.

1940

By February, after having suffered heavy losses, the Soviet Union exhausted the Finns and a peace was concluded. In April, Germany used airpower to overwhelm Denmark and Norway, offsetting German inferiority at sea. On 10 May, Germany invaded the Low Countries, its Luftwaffe again spearheading the attacks in the Battle for France. The inadequate Allied air forces caused the Germans some casualties, but they were defeated in the air and on the ground. Luxemburg, Belgium, and Holland were quickly overrun. In late May, the Royal Air Force succeeded in preventing the Luftwaffe from interfering with the evacuation at Dunkirk. This was the first defeat the German air force had suffered. By 21 June, France had surrendered. Great Britain upped the ante in the air war, sending bombers to attack targets in Germany, particularly in the Rhineland.

After his lightning victories, Adolf Hitler offered Great Britain peace—but at too great a price. The United Kingdom was now led by Prime Minister Winston Churchill, a longtime supporter of airpower and a man who was determined



The Heinkel He 111 was one of the most commonly used aircraft in the Luftwaffe. This German all-metal monoplane was just one of the many innovations developed in World War II. (U.S. Air Force)

never to surrender. He was exactly the right man for the job, for he brought the United Kingdom back from the brink of despair and set about building a bombing force that he hoped would punish Germany.

In the meantime, Germany attempted to establish air superiority over England in the Battle of Britain. It was here that timing and technology first began to work against the Germans, for the aircraft (Messerschmitt Bf 109s, Heinkel He 111s, Dornier Do 217s, and Junkers Ju 87s and Ju 88s) that had been perfect for a continental campaign were now too few in numbers and technologically inadequate for a strategic bombing campaign. Timing and technology worked instead for Great Britain, whose factories were churning out hundreds of Hurricanes and Spitfires and whose radar system formed the core of an integrated command-and-control system that would enable the RAF to decisively defeat the Luftwaffe. Defeated in the Battle of Britain, Germany realized that invasion was impossible and turned to nighttime bombing of British cities even as the Nazis reorganized their forces for an invasion of the Soviet Union. Events in Europe had served to alert the United States that it was necessary to increase production capacity, and Allied investment in the U.S. aviation industry aided this effort. Large orders for combat aircraft were placed by England and France (with smaller orders being placed by other countries), which prompted an expansion of the U.S. aviation industry—critically important in the coming years. Japan began the occupation of French Indochina in an effort to move closer to the vital oil and mineral resources of Southeast Asia. On 28 October, Italy invaded Greece from its Albanian bases. The invasion was inadequately prepared, and the Greeks proved to be tough adversaries who promptly forced the Italians back beyond the Albanian frontiers. Great Britain sent troops and aircraft to Greece, beginning a relatively small but politically important air battle there.

1941

German bombing of the United Kingdom continued through May 1941 but on a reduced scale. In Africa, very limited British forces were able to maul Italian armies in Libya and in Eritrea and Ethiopia. The defeats in Libya would cause Hitler to send the Afrika Korps, with limited but very effective air components, to rescue the Italians. This would begin the long, bitter North African campaign. In eastern Africa, there were dogfights between biplane opponents, with Gloster Gladiators contesting Fiat Falcos in a World War I–type atmosphere. Air attacks on Malta began to build in intensity. The United States moved closer to open warfare by announcing its Lend-Lease plan, whereby it would provide arms to Great Britain on a massive scale. On 6 April, Germany began its Balkan campaign, which was massively successful and ended with the evacuation of Greece by British forces and the occupation of Crete. It had the effect, however, of delaying the German invasion of the Soviet Union, which many observers feel was critical to the outcome of the 1941 campaign. On 22 June, German launched Operation BARBAROSSA, its invasion of the Soviet Union. The Soviet air force was virtually destroyed on the ground, but once again the scale of German air effort was hopelessly inadequate, and despite overwhelming success, the fighting ground down in the winter snows. The Soviet Union began a massive relocation effort that saw no less than 1,523 factories moved beyond the Urals.

On 7 December, imperial Japan began a whirlwind air campaign with the attack on Pearl Harbor and the Philippines. Japanese airpower would soon seem to be invincible as it swept through Southeast Asia, sinking HMS *Prince of Wales* and *Repulse* in passing. It would be dominant for the next six months of the war. Germany declared war on the United States on 11 December.

1942

The Japanese forces, employing relatively small but highly effective elements of airpower, conquered some 20 million square miles of territory, including the Philippines, Malaya, the Dutch East Indies, and Burma, along with critical Pacific islands such as Wake and Guam, by March 1942. The only ray of hope came in the famed 18 April Doolittle Raid on Tokyo, the first of many. In Europe, the RAF became increasingly aggressive with daylight fighter and bomber sweeps over occupied territories. In March, RAF Bomber Command began its new offensive, intensifying the nighttime bombing of Germany. The United States would join Great Britain in the Combined Bomber Offensive, which would grow from modest beginnings to an overwhelming force over the next three years. In the Atlantic, German U-boats began a war against shipping that would become known as the Battle of the Atlantic; they would succeed for more than a year because of inadequate Allied airpower.

The war in the Pacific took a sudden and surprising turn in favor of the Allies following the Battle of Midway in early June. On August 7, the United States would invade Guadalcanal, beginning a bloody six-month battle that would literally turn on the possession of a single facility—Henderson Field. In Russia, German advances continued to the south toward Stalingrad and the Caucasus. In Africa, Germany would suffer a major defeat at El Alamein in October, then be confounded by the massive U.S. invasion of North Africa on 8 November. Allied airpower in every theater was causing the tide of war to shift.

1943

The fortunes of war turned irreversibly against the Axis powers in 1943, beginning with the catastrophic German losses in the Battle of Stalingrad. The Luftwaffe could still attain local air superiority at specific spots along the Eastern Front, but the Soviet opposition was gaining both in numbers and tactics. The effectiveness of Soviet airpower and the decline in the Luftwaffe's strength was demonstrated in the Battle of Kursk, the largest tank battle in history. Germany also suffered defeat in the Battle of the Atlantic, where the combination of land- and carrier-based aircraft shut down all areas of operation by the U-boats and, in cooperation with surface ships, caused prohibitive losses. The Germans were also defeated in North Africa, which was followed by defeats throughout the entire Mediterranean Theater with the loss of Sicily and the invasion of Italy. At the same time, the Combined Bomber Offensive grew in intensity and effectiveness over Europe, exemplified by the destruction of Hamburg. The Luftwaffe was still capable of dealing out tremendous punishment, however, as in the air battles over Regensburg, Schweinfurt, and Berlin.

In the Pacific, the defeat at Guadalcanal forced the Japanese on the defensive throughout the theater as Allied forces followed a two-axis strategy. The first was a step-by-step advance toward the Philippines by the forces of General Douglas MacArthur, the second an island-hopping advance under the direction of Admiral Chester Nimitz. The island-hopping campaign was characterized by bitter battles such as Tarawa.

1944

Allied airpower came into its own in Europe with the introduction of long-range escort fighters and a new philosophy that was aimed at destroying the Luftwaffe. By March 1944, the Luftwaffe had been soundly beaten; although it was occasionally able to muster strength for savage attacks, it was never again able to secure daytime air superiority. However, in the same month the Luftwaffe did defeat the RAF in its nighttime-bombing campaign against Berlin. The combined USAAF/RAF forces focused on preparing the European continent for an invasion; the 6 June 1944 D-Day operation was so successful that it was virtually unopposed by the Luftwaffe. The air battle over Germany intensified and was regarded as a "second front" by no less an observer than Albert Speer even before the D-Day landings.

In the Pacific, the airpower of the U.S. Army and Navy proved superior to the Japanese at every point. The Japanese were now desperately short of trained pilots, so much that their remaining aircraft carriers were sometimes forced to sortie as mere decoys without any aircraft aboard. They incurred massive defeats in the Marshall Islands and the Philippines and were forced to resort to kamikaze suicide tactics.

In the last days of 1944, the Germans took advantage of bad weather, which hampered Allied air operations, to launch their final offensive of the war in the West—the Battle of the Bulge. As soon as the weather cleared a bit, however, Allied airpower reasserted itself.

1945

Airpower played itself out in Europe; useful targets disappeared by April, and the Germans surrendered in May. In the Pacific, true airpower came into being for the first time in the B-29 fire-bombing of Japan, which reduced major cities to ashes. The Japanese militarists still refused to surrender until the application of absolute airpower in the form of atomic weapons on Hiroshima and Nagasaki.

It is worth noting that the final application of airpower in both the European and Pacific theaters was compassionate, with the dropping of food, clothing, and medical supplies to POWs still held in the defeated enemies' camps.

Walter J. Boyne

See also

Arnold, Henry H. "Hap"; Atlantic, Battle of the; Atomic Bomb; BARBAROSSA; Blitzkrieg; Britian, Battle of; Bulge, Battle of the; Combined Bomber Offensive; Crete, Battle of; Dunkirk; El Alamein, Air Battles of; France, Battle for; German Air Force (Luftwaffe); Goering, Hermann; Guadalcanal; Guam, Battles of; Hamburg Bombing Campaign; Hiroshima; Kamikaze Attacks; Kursk, Battle of; Malta, Siege of; Mediterranean Theater of Operations; Midway, Battle of; Nagasaki; Nimitz, Chester William; North African Campaign; Philippines; Spaatz, Carl Andrew; Stalingrad, Battle of; Tarawa, Battle of; Tokyo Air Raids; Wake Island, Battles of

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World War II Conferences

Generally, the 1943 wartime conferences of Allied leaders that helped shape airpower practice and operations.

The Casablanca Conference (code name SYMBOL) took place during 12–23 January 1943. President Franklin D. Roosevelt and Prime Minister Winston Churchill met with their chiefs of staff to formulate joint policies. Earlier differences on the invasion of Europe were resolved in favor of a landing on Sicily to take Italy and a delay to prepare for a cross-channel assault in northern France. Roosevelt's demand for unconditional surrender of the Axis and steps to reduce the German U-Boat menace gained British acceptance. They also discussed nuclear bomb research, as well as matters of French leadership in the war against the Axis.

General Henry H. "Hap" Arnold, U.S. Air Corps Chief of Staff, a member of the Joint Combined Chiefs of Staff assigned to develop an Allied air strategy, was embarrassed by the size and preparation of the British air staff delegation and immediately flew in General Ira Eaker of the Eighth Air Force, the most knowledgeable officer in bomber command. The British proposed that Americans join in the nighttime bombing of Germany. Eaker argued that U.S. crews trained for daylight bombing faced great losses in transitioning to night attacks. Arnold and Eaker convinced Churchill that the daylight bombing attracted German fighters that were then destroyed and provided round-the-clock bombardment, giving Germany no relief from air attack. They agreed on the Combined Bomber Offensive (CBO): The British would bomb industrial areas at night while Americans would seek precision targets during daylight bombing; Allied air forces thus assumed independent strategic missions complemented by tactical support of theater forces. It was resolved that when the new B-29 bombers became available they would be assigned to England, rejecting the British choice of North Africa, to bomb Germany.

The Casablanca Conference also took up the air war against Japan in detail. FDR insisted China be kept in the war, despite the problem of flying over the Hump from India to China, until a land connection to China was reestablished. The British accepted the U.S. explanation for a strong course of action against Japan and agreed to resolve the problems of China-Burma-India (CBI) support. George C. Marshall, grappling with the disagreement on China policy between Lieutenant General Joseph W. Stilwell and Major General Claire L. Chennault, believed that Japanese industrial production could be crippled under air assault. FDR agreed, convinced that bombing Japan would uplift Chinese morale, and he unrealistically proposed sending 200–300 planes to China despite the acknowledged logistics problems. Marshall did not share this view. After the conference, FDR wired Chiang Kai-shek that Arnold would visit China to discuss air aid to Chennault's Fourteenth Air Force to increase the offensive against Japan in China and to deliver FDR's letter promising air support. On 10 April 1943, Chiang wrote to FDR requesting that General Chennault return to Washington to present his ideas for an air offensive against Japan. Arnold yielded to a fuller airing of the Stilwell-Chennault feud. In May 1943, a few days before the so-called Trident Conference was to open in Washington, D.C., Arnold had a heart attack and was unable to attend the proceedings.

The Trident Conference took place during 15–25 May 1943. FDR, Churchill, and their chiefs of staff met to plan war strategies; Chennault and Stilwell were brought in to present their respective cases. The challenge of the CBI theater was compounded by Stilwell and Chennault's disagreement on overall strategy. General Stilwell, known as "Vinegar Joe" for his acerbic temperament, was U.S. theater commander and Chief of Staff to Chiang Kai-shek, and General Chennault commanded the newly formed Fourteenth Air Force.

Chennault went to China as air adviser to Chiang in 1937 and had trained Chinese pilots as well as an international squadron of mercenaries in effective tactics to support Chinese ground troops and challenge Japanese air units in China. Prior to Pearl Harbor, he had created, with the clandestine support of FDR, the American Volunteer Group—the famous Flying Tigers. Chennault, prone to exaggeration, proposed to drive Japan out of China with an air force of 500 planes if properly supplied and maintained.

Stilwell, an infantry officer whose forces were earlier driven out of Burma, proposed to equip and train a large Chinese army to recapture Burma and open a supply road to China. Chennault countered that the supplies necessary to equip the Chinese armies would effectively halt most of his air logistics. As the British wished not to risk a massive effort in Burma, they supported Chennault's views.

Chennault called for an increased airlift to supply the Fourteenth Air Force so that his bombers could push the Japanese back and destroy Japanese merchant shipping off the Chinese coast, then retake Hong Kong as a port for supplies to enter China. This approach depended on Allied control of the China Sea, including the Philippines and Formosa (Taiwan) to be used as bases, something not scheduled until 1947. Stilwell retorted that the Chinese armies under Chiang could not hold the eastern airbases around Guilin (Kweilin) once the Japanese retaliated for the increased air attacks on them. Without clear resolution, it was determined to assign more aircraft to boost supplies over the Hump to 10,000 tons per month by 1 September 1943. Asia would again be taken up in the Quebec Conference at the end of the summer.

Following discussion of CBI issues, attention turned to the European theater. The CBO plan was refined at Trident and designated Operation POINTBLANK, its goal to destroy German industries essential to the manufacture of weapons and war activity. In addition to formalizing the strategic bomber offensive against Germany, the principals agreed to a plan for a cross-channel invasion of Europe through France for 1 May 1944.

The Quadrant Conference (Quebec I) took place during 14–24 August 1943. U.S. military planners sought to thwart Churchill's earlier demand that the Allies drive through Italy in the wake of Mussolini's collapse. U.S. Secretary of State Henry L. Stimson stiffened FDR's resolve to limit U.S. deployment into Italy after Sicily (HUSKY) in order to prepare for the cross-channel invasion into France. Roosevelt and Churchill also discussed drawing the Soviet Union fully into the Western Allies' war plans, and Charles de Gaulle was designated the representative of all Free French forces.

Since Trident, U.S. planners focused on the pending deployment of the new B-29 bomber against Japanese homeland targets. At Quadrant, Arnold submitted the plan of Major General Laurence Kuter, called SETTING SUN, which proposed the destruction of Japan's war industries by B-29s flying from Chinese bases within 1,500 miles of Japanese targets. The plan predicted with remarkable effectiveness that 70 B-29s, each flying five missions per month, could destroy Japan by August 1945.

The plan was sent to Churchill, Chennault, and Stilwell for consideration. Stilwell argued that limited port facilities in Calcutta and the difficulties of getting supplies from India to China made it unworkable. He proposed a plan called TWILIGHT, which would base the B-29s in the Calcutta rear area and fit some B-29s with bomb-bay tanks for use as tankers over the Hump. The rest of the fuel and supplies could be flown over the Hump by cargo planes. This would eliminate the need for a supply port on the Chinese Sea and allow bombing operations to begin by April 1945, with 10 B-29 groups flying an average of 500 sorties per month. The Combined Chiefs' interest in the plan waned when Stilwell insisted that he be given provisions to equip and train 50 Chinese divisions to defend the forward eastern bases. Chennault maintained that with appropriate supplies, the Fourteenth Air Force and the Chinese army could protect the bomber bases that he proposed to place along the Kweilin-Changsha railroad. It was decided to use the B-29s to haul fuel in bomb-bay tanks as Stilwell proposed and to place the planes in forward bases in Chengtu, China. Operation MATTERHORN, the first bombing of Japan by B-29s from Chinese bases, was tentatively scheduled for 1 May 1944. The various wartime conferences had immediate effect on the conduct of the war, as well as long-range postwar effects not perceived at the time.

Richard C. DeAngelis

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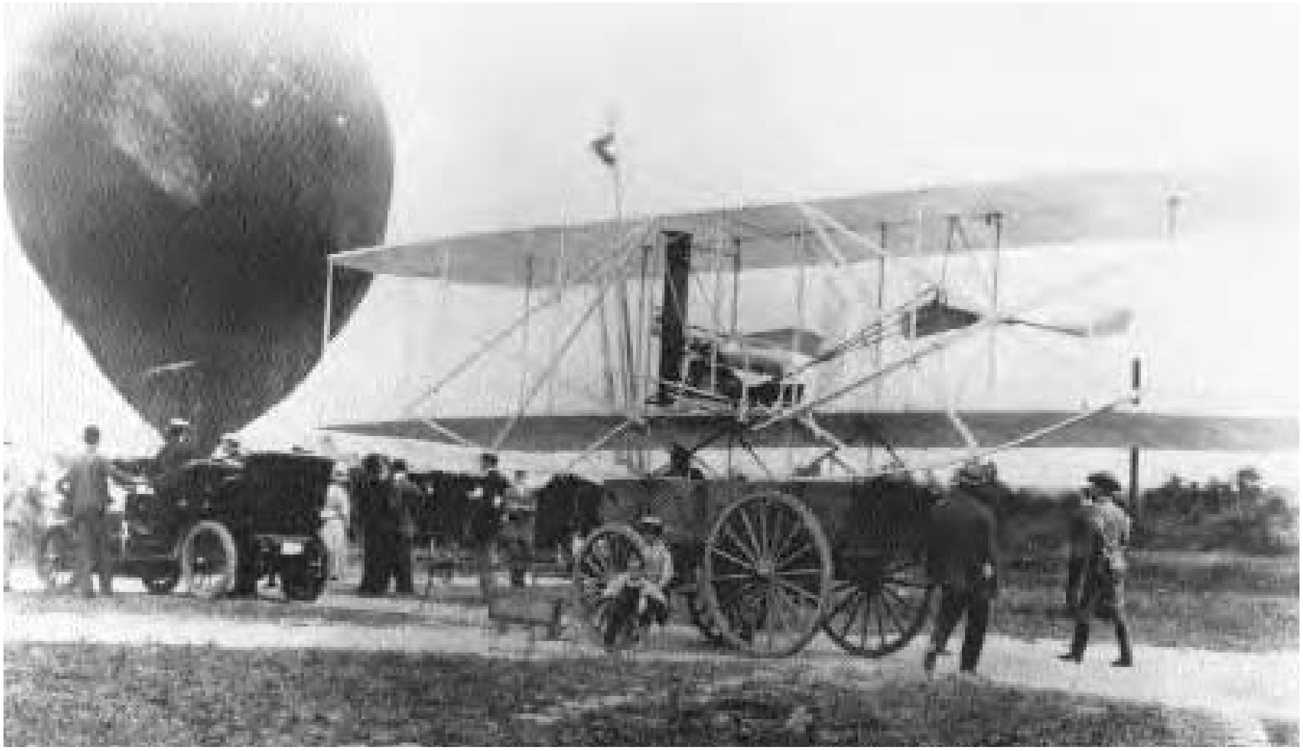
Wright, Orville (1871–1948)

Inventor, with brother Wilbur (1867–1912), of the airplane. He was born in Dayton, Ohio. At Kitty Hawk, North Carolina,



Transportability was a major requirement in the contract calling for a military airplane, and the Wrights demonstrated it with ease. (U.S. Air Force)

on 17 December 1903, Orville Wright became the first person to sustain a controlled flight of a man-operated, motor-driven aircraft. Building on the previous work of Otto Lilienthal, Octave Chanute, and Samuel Langley, the Wright brothers began building gliders in 1900. In late 1902, after more than 1,000 flights, they designed and built a plane with a light (150 pounds), powerful (12 horsepower at 2,000 rpm) engine and hand-carved propellers. In 1903 at Kitty Hawk, Orville flew the *Flyer I* 12 seconds and 120 feet. In 1905, *Flyer III* became the world's first practical airplane. It was maneuverable and could remain airborne for more than half an hour. The Wrights received a patent for the airplane on 22 May 1906. In 1908 at Fort Myers, Virginia, Orville won a competition for the world's first military airplane. Later that year, he became the first pilot to kill his passenger (Lieutenant Thomas Selfridge).

After Wilbur died of typhoid fever in 1912, Orville continued flying actively until 1915. He sold his interest in the Wright Company for $1.5 million, then retired to serve on the National Advisory Committee for Aeronautics and continued inventing household gadgets. Wright never married.

John Barnhill

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Wright, Wilbur (1867–1912)

Inventor, with brother Orville (1871–1948), of the airplane. Wilbur, the older of the two aviation pioneering brothers, was born on 16 April 1867 on a small farm near Millville, Indiana. His father had a strong influence over Wilbur and all his siblings. He and younger brother Orville did not smoke, drink, or get married. Neither brother got more than a partial high school education. In many respects, Wilbur and Orville, like Thomas Edison of a previous generation, developed their careers very much in the tradition of the classic American inventive tinkerers who employed instinct, intuition, and endless intelligent effort to fashion new machines and innovative theories.

After the family moved to Dayton, Ohio, Orville Wright became an expert bicyclist. In the late 1880s, as the brothers became adults, they decided to make their living in the bicycle business. They were also fascinated by gliders and closely followed the career of the famous German glider pioneer Otto Lilienthal. By the time Lilienthal was killed in 1896, both brothers had become students of flying.

By 1899, the Wrights were convinced they could combine their interests and expertise to create a machine-driven heavier-than-air aircraft. By the fall of 1903, the brothers had constructed a fragile and elegant airplane with a 40.5-foot wingspan weighing 750 pounds with the pilot. Among the most important design features was wing warping (the ancestor of ailerons), which enabled them, with the elevators and a moveable rudder, to have three-axis control.

Only 10 days before they planned to make experimental flights near Kitty Hawk, North Carolina, Samuel Langley had failed in his second very public attempt to fly. The Wrights had selected Kitty Hawk because of its wide-open sand dunes and strong winds. It had been perfect for glider-testing, and now they hoped it would help them fly their powered aircraft.

On 17 December 1903, on Kill Devil Hill, near Kitty Hawk, Orville Wright made what has been credited as the world's first flight in a powered, manned, heavier-than-air machine. The aircraft flew 120 feet in 12 seconds. The distance is about half the length of the wingspan of a modern C-5 Galaxy transport. With only a handful of spectators present to witness the historic event, the brothers made three more flights that day. The longest flight, by Wilbur, measured 852 feet and lasted 59 seconds.

Over the next several years they worked, mostly in the Dayton area, to perfect what later became known as the Wright Flyer. Still, many people did not believe that they had flown. In late 1905, the editors of *Scientific American* magazine suggested in one article that the Wrights' claim was a hoax. That same year, as if to prove their critics wrong, Wilbur made a very public 24-mile flight lasting more than 30 minutes. In 1906, they also received patents for many of the important features they had developed for their plane.

Of course, the primary purpose of building the aircraft was to sell it and make money. The most likely buyer was the U.S. Army. On 10 February 1908, the Wrights negotiated a contract to sell a heavier-than-air flying machine to the U.S. Army Signal Corps. Initial flying trials began on 3 September and unfolded with remarkable success. However, they came to an abrupt halt on 17 September when one of the new wooden propellers split at 125 feet and the Flyer crashed. Orville was seriously injured; his passenger, Lieutenant Thomas Selfridge, became the first person to die in a powered aircraft crash.

The trials resumed the next summer and officially lasted from 29 June to 30 July 1909. They exceeded all expectations. During test flights, Orville flew the pusher-style aircraft to a record altitude of 500 feet and once made a 10-mile cross-country flight, with Lieutenant Benjamin D. Foulois, at the "unbelievable" speed of 42.5 mph. On 2 August 1909, the Army accepted what became known as Signal Corps Flyer Number One and paid the Wrights $25,000. That aircraft is currently on exhibit at the National Air and Space Museum.

On 30 May 1912, Wilbur Wright died of typhoid fever during an epidemic that struck Dayton. Orville was devastated and soon all but retired from the aviation business. Even though he won the 1913 Collier Trophy and remained active with the National Advisory Committee for Aeronautics, by 1915 Orville had sold his holdings in the Wright Aircraft Company.

William Head and Brian Head

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Wright-Patterson Air Force Base

U.S. Air Force base located approximately 10 miles northeast of Dayton, Ohio. It is one of the largest military installations, having more than 500 buildings on a property area of 8,143 acres. Main active runway 05L/23R is 12,600 feet long and 300 feet wide. Employment exceeds 20,000 combined military and civilian personnel in more than 70 different units. Headquarters of the U.S. Air Force Material Command (AFMC), with major tenant units being the Aeronautical Systems Center, Air Force Research Laboratory, Air Force Institute of Technology, National Air Intelligence Center, and Air Force Museum. AFMC organizations located at other bases across the country include product centers, test centers, and logistics centers performing the integrated management of research, development, test, acquisition, and support of aerospace weapons systems.

Wright-Patterson AFB developed from four earlier military installations: Wilbur Wright Field, Fairfield Air Depot, McCook Field, and Wright Field. Wilbur Wright Field began operations on 28 June 1917 as a training installation. The field was named in honor of the late Wilbur Wright, who with brother Orville invented the airplane. The property area of Wilbur Wright Field included Huffman Prairie, where the

McCook Field, the birthplace of experimental aviation in the United States. There was a sign on the field saying "This Field is Small, So Use it All"—still good advice today for any pilot. The Xs on the rooftops are directional signals to various cities. (U.S. Air Force)

Wright brothers conducted their flying activities after their initial successful experiments at Kittyhawk, North Carolina.

In the fall of 1917, construction began for the Fairfield Air Depot, located adjacent to Wilbur Wright Field and near the village of Fairfield. The depot provided logistics support to U.S. Army Signal Corps aviation installations in the Midwest. Although the two installations initially were administered independently, beginning 10 January 1919 they were merged. A name-change took place on 1 July 1931 when the complex became Patterson Field in honor of Lieutenant Frank S. Patterson, who died in a flight-test accident.

McCook Field opened on 4 December 1917 as the U.S. Army Signal Corps's home of the Airplane Engineering Division. The field was located immediately north of downtown Dayton on 254 acres. Its name honored the McCook family of Dayton. The facilities and projects at the field included engineering laboratories and flight-testing for the advancement of military aeronautical technology. The technical staff performed engineering developments in virtually all subjects, including aircraft design, engines, propellers, materials, parachutes, flight clothing, and aerial photographic equipment. The pilots assigned to flight testing included several notable personalities, among them Major Rudolph W. Schroeder, Lieutenant James H. Doolittle, and Lieutenant John A. Macready. These men compiled an impressive list of aviation achievements, establishing records for altitude, speed, and distance.

McCook Field is remembered for the sign painted on the main hanger that proclaimed "THIS FIELD IS SMALL—USE IT ALL." The single paved runway was only 1000 feet long and 100 feet wide. The small size and urban setting of McCook Field ultimately rendered the facility unsuitable for aviation activities.

Construction began on 16 April 1926 for a new installation 8 miles east of Dayton to replace McCook Field. At the formal dedication on 12 October 1927, it was given the name Wright Field to honor the Wright brothers. The transfer of all personnel and equipment from McCook Field was completed by May 1929. Wright Field was the headquarters of the Material Division, with responsibility for research, engineering, supply, procurement, and maintenance. Today, it is headquarters for the Aeronautical Systems Center, which directs procurement of aeronautical systems, and for the Air Force Research Laboratory, which has facilities at Wright Field and other installations around the country. The Air Force Museum is located on a portion of the deactivated flying field.

During World War II, Patterson Field and Wright Field added facilities and expanded the workforce to a size several times greater than prewar levels. New hangers, shops, laboratories, and warehouses were constructed. For the years 1942–1944 the combined military and civilian personnel strength exceeded 45,000 each year. Patterson Field was a major wartime logistics center, and Wright Field was the center of aeronautical research, development, and procurement. Nevertheless, the demands of the war and the increasing complexity of military aircraft necessitated moving some functions to other locations. For example, experimental flight test moved to Muroc Field (now Edwards AFB), and armament testing projects moved to Eglin AFB. In the 1950s, most propulsion and wind-tunnel testing moved to the new Arnold Engineering Development Center near Manchester, Tennessee.

Patterson Field and Wright Field continued as separate installations through World War II. After the war a plan to establish joint administration of the two was approved. Wright-Patterson AFB became a single base on 13 June 1948. Aircraft operations continued using the runways at both fields until 1976, when the Wright Field runways were deactivated. All flight operations now are conducted from the Patterson Field aerodrome.

Squire L. Brown

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Y

Yakovlev, Aleksandr S. (1906–1989)

Russian aircraft designer. Aleksandr Sergeevich Yakovlev was born in Moscow on 19 March 1906. He began designing mainly light aircraft in the 1920s under the sponsorship of Sergei Ilyushin. His first combat aircraft were the Yak-4 light bomber, which flew in 1939, and the Yak-1 fighter of 1940. The Yak-4, sleek-looking but underpowered and plagued with structural problems, was total failure and withdrawn from service almost immediately after the start of war. The Yak-1 made Yakovlev's reputation and established him as Stalin's favorite designer, though other Soviet designers accused him of being a back-stabber and toady. Of mixed metal and wood construction, the Yak-1 was fast and maneuverable, and the approximately 400 examples produced by June 1941 were the only fighters capable of meeting the German aircraft on near-equal terms. Even after introduction of the evolved Yak-7, Yak-9, and Yak-3, the Yak-1 remained in production until 1944, with 8,670 examples produced, and several Yak aces expressed a preference for the earlier model. The Yak-7 and Yak-9 were heavier versions, with greater power and longer range, while the Yak-3 was a lightweight low-altitude fighter, possibly the best dogfighter of the war. By Victory Day, 32,361 Yak fighters of all types had been produced; after the war the Yak-9P was produced, bringing total production to more than 36,300 Yaks, the second-most produced combat aircraft in history after the 39,000 Il-2 Shturmovik variants.

The Yak-3 also served as the basis for the Soviets' first generation of jet fighters, the Yak-15 and Yak-17, of which 710 were produced from 1946 to 1948. Essentially basic Yak airframes fitted with a Jumo jet engine, they lost out to the more modern MiG-15, and Yakovlev never regained his preeminence. Another derivative of the wartime fighters was the Yak-11 trainer, the basic Yak airframe equipped with a lower-power radial engine. The success of this aircraft led to a series of other propeller-driven trainers, the Yak-12, Yak-18 and Yak-52, which were produced in large quantities and used for training throughout the communist world and by Third World nations; they have recently appeared in the West as sporting aircraft.

During the early 1950s, Yak built a few examples of the tandem-rotor Yak-24 helicopter, but it was not very successful, and further helicopter development was abandoned to Mil and Kamov. Yakovlev produced one more successful combat aircraft family. The Yak-25 Flashlight entered service in 1953. A strange-looking swept-wing jet with two engines under the wings and a bulbous nose housing a radar, it was used only as an interceptor. The 547 examples produced served only with the Soviet air defense units, were not exported, and never saw combat before being retired in the early 1960s. However, in 1959 an unarmed high-altitude reconnaissance version, the Yak-25 RV Mandrake, was introduced, able to reach 64,000 feet.

Also introduced in 1959 was a much more modernized aircraft of obvious lineage, the Yak-28 Brewer family. The Brewer, produced in 837 copies, served as a tactical bomber and reconnaissance aircraft and later as an electronic-warfare platform. Also members of the family were 160 Yak-27 Mangrove reconnaissance aircraft and 437 examples of the Yak-28P Firebar all-weather interceptor. Like the Flashlight, none of these aircraft were exported or saw combat, but the Brewers proved long-lived, the last examples remaining in Ukrainian service as late as 2000.

From 1973 to 1988, Yakovlev also produced a series of 231 VTOL jets, the Yak-38 Forger, for operation from aircraft carriers, but this aircraft gained an evil reputation with crews.

Aleksandr Yakovlev died on 22 August 1989.

George M. Mellinger

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Yamaguchi, Tamon (1892–1942)

Imperial Japanese Navy rear admiral. Born in 1892, Tamon Yamaguchi graduated from the Japanese Naval Academy in 1912 and from the Naval War College in 1925. He spent three tours in the United States, including one as naval attaché (June 1934–August 1936). He also attended Princeton University. He was one of Japan's most passionate advocates of naval airpower. The pilots he commanded admired him and considered him one of their own. One Japanese author called him "the bravest officer in the Japanese Navy." He was promoted to rear admiral in 1938 and to command of the Second Division of the main Japanese carrier strike force in 1940.

Yamaguchi, unlike most Japanese admirals of his time, had an aggressive and decisive style and personality. Some describe him as "impulsive" or "devil-may-care." He was a very close confidant of Admiral Isoroku Yamamoto, and many historians consider him Japan's most gifted wartime carrier officer. He was the most outspoken supporter of Yamamoto's plan to attack Pearl Harbor and later his plan to attack Midway. He and the carrier commander, the cautious Vice Admiral Chuichi Nagumo, were often at odds and nearly came to blows on several occasions.

Originally, left out of the Pearl Harbor operation because of concerns over fuel consumption and range, Yamaguchi demonstrated such a devotion to the plan that Yamamoto was convinced he should include Yamaguchi's carriers. During the Pearl Harbor operation, Yamaguchi commanded the Second Division, consisting of *Soryu* and the flagship *Hiryu.* It was Yamaguchi who urged Nagumo to make follow-up strikes on Pearl Harbor facilities and to seek out and destroy the U.S. carriers that had not been present on 7 December 1941. Upon returning to Japan, Yamaguchi's carriers were sent to support Japanese operations against Wake Island.

From 31 March to 10 April 1942, he again commanded the Second Division during successful Indian Ocean operations against the British. Seven weeks later, Yamaguchi and the Second Division participated in the pivotal Battle of Midway.

Again, Yamaguchi and Nagumo disagreed on tactics. When the Japanese discovered the USS *Yorktown,* Yamaguchi advocated an immediate attack and search for other carriers. Nagumo hesitated, trying to decide whether to attack Midway again or the carriers. His delay left the Japanese carriers vulnerable to air attacks. On 4 June 1942, three of the four Japanese carriers were fatally bombed by U.S. Navy dive-bombers. At 10:30 A.M., with his carrier *Akagi* sinking, Nagumo transferred command of air operations to Yamaguchi.

Yamaguchi immediately launched 18 dive-bombers and six fighters against the *Yorktown.* Although only eight returned, they hit the *Yorktown* three times, leaving it dead in the water. An hour later *Yorktown* was under way, only to be struck again by a second wave of 10 Kate torpedo-bombers and six fighters. Eight more Japanese planes were lost, but two torpedoes struck the *Yorktown,* leaving it listing and dead in the water. Despite efforts to save the carrier, a Japanese submarine later sank it.

As a third strike with only 10 planes was prepared by Yamaguchi, 24 dive-bombers from the USS *Enterprise* and *Yorktown a*ttacked the *Hiryu* at about 5:00 P.M., mortally wounding it. Steeped in samurai tradition, Yamaguchi assumed blame for the ship's loss and refused to leave. At 2:30 A.M. on 5 June, the 800 survivors of *Hiryu* abandoned ship. Two hours later, the last officers also departed. Yamaguchi was last seen reciting poetry and sipping tea. The ship was scuttled at 5:10 A.M. but did not sink until 9:00 A.M.

Many believe that had Yamaguchi been in command the Japanese might have been more decisive in launching strikes against U.S. carriers. Considering the effect that *Hiryu*'s limited strikes had on the *Yorktown,* the argument has at least some merit. Some blame for the defeat must fall on Admiral Yamamoto's excessively complex battle plan. But the excellence of Japan's enemy had more to do with their defeat at Midway than poor military decisionmaking.

William Head

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Yamamoto, Isoroku (1884–1943)

Imperial Japanese Navy (IJN) admiral; mastermind behind the Pearl Harbor operation. Isoroku Yamamoto was born on 4 April 1884 in Nagaoka, Japan. He graduated from the

Japanese Naval Academy in 1904 in time to fight during the Russo-Japanese War (1904–1905). After the war he attended the Imperial Naval War College. From 1919 to 1921, he attended Harvard University.

In the early 1920s Yamamoto, a carrier pilot himself, became a proponent of naval airpower. Generally considered an expert, he used his growing authority to effect the design, construction, and deployment of first-class naval aircraft. In 1925, Captain Yamamoto served as the naval attaché in the Japanese embassy in the United States. During this time, he observed the industrial power of America and also came to realize that carriers were eclipsing battleships in strategic importance.

Between 1936 and 1940, he earned the disdain of the Japanese right wing because he opposed war with the United States. He openly denounced the Axis Tripartite Pact, fearing Japan's aggressive foreign policy would incite America to war. He believed U.S. industrial might could lead to disaster and defeat for Japan. In 1940, he told one cabinet minister, "In the first six to 12 months of the war with the United States and Great Britain I will run wild and win victory upon victory. But then if the war continues after that, I have no expectations of success."

In August 1941, still opposing war with the United States, he was made commander in chief of the entire Imperial Japanese Navy and ordered to prepare the Combined Fleet for war. Yamamoto planned and led what he hoped would be a decisive blow. Although the 7 December 1941 attack on Pearl Harbor sunk five U.S. battleships, the U.S. carriers were not present and the results were far from decisive.

For five months the IJN roamed the Pacific unchecked. The Battle of the Coral Sea in May 1942 halted the advance. The Doolittle Raid against Tokyo (18 April 1942) pushed Yamamoto into an attack on Midway Island to secure the eastern sea approaches to Japan. At Midway Yamamoto created a complex plan involving naval air attacks against U.S. installations at Midway, decisive engagements with U.S. carriers, an amphibious landing on Midway, and a diversionary attack on the Aleutians. The IJN lost four carriers and most of its best pilots during the June battle. It was the turning point in the Pacific War.

He continued as Combined Fleet commander, leading his forces against the United States during the naval battles around Guadalcanal and the Solomon Islands. In an effort to improve morale and combat performance, Yamamoto conducted an inspection of Japanese airfields in southern Bougainville. When U.S. code breakers intercepted his itinerary, a plan was formulated to ambush his plane. On 18 April 1943, exactly one year after the Doolittle Raid, the Thirteenth Air Force intercepted Yamamoto's G4M Betty bomber just outside Kahlil Field, Buin, and shot it down, killing Yamamoto.

Yamamoto was given a state funeral and posthumously promoted to Admiral of the Fleet. Most experts believe that Yamamoto's death had a devastating impact on his forces and nation. Others, viewing his repeated mistakes, feel that his death benefited Japan, although the Japanese never perceived this.

William Head

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Yeager, Charles E. (1923–)

U.S. Air Force general. Charles E. "Chuck" Yeager was born in Myra, West Virginia, on 13 February 1923. He graduated from high school in Hamlin, West Virginia. He enlisted in the U.S. Army Air Corps in September 1941, was accepted for pilot training under the flying sergeant program in July 1942, and received his pilot wings and appointment as a flight officer in March 1943 at Luke Field, Arizona.

During World War II, Yeager distinguished himself in aerial combat over France and Germany during the years 1943–1945 by shooting down 13 enemy aircraft, five during one mission alone. He was also one of the first to down Germany's new jet-powered fighter, the Messerschmitt Me 262. On 5 March 1944, he was shot down over German-occupied France but escaped capture when elements of the French Maquis helped him to reach the safety of the Spanish border. He then returned to combat.

He returned to the United States in February 1945 to attend the instructor-pilot course, after which he served as an instructor pilot. In July 1945, he went to Wright Field, Ohio, where he received his first experimental flight-test work. His assignment there led to his selection as pilot of the nation's first dedicated research airplane, the rocket-powered Bell X-1, at Edwards AFB, California, where he served from mid-1947 to late 1954. Yeager made world history on 14 October 1947 when he became the first person to fly faster than the speed of sound while flying the Bell XS-1 (later X-1) rocket-powered airplane at Edwards AFB.

During 1952 he attended the Air Command and Staff College. He also became the second person to fly at more than twice the speed of sound while piloting the improved Bell X-1A on 12 December 1953. He was the nation's leading test pilot for nine years.

He returned to Europe in October 1954 and became commander of the 417th Fighter Squadron at Hahn Air Base, Germany, in May 1955. He remained in that position when his squadron was reassigned to Toul-Rosieres Air Base,

Strangely enough, Chuck Yeager received no publicity when he broke the sound barrier on 14 October 1947; the mission was too classified. It was many years later before he became the folk hero he is today. (U.S. Air Force)

France, in April 1956. Upon his return to the United States in September 1957, he was assigned to the 413th Fighter Wing at George AFB, California, and in April 1958 he became commander of the 1st Fighter Squadron.

Yeager graduated from the Air War College at Maxwell AFB, Alabama, in June 1961 and became commandant of the Aerospace Research Pilot School at Edwards AFB in July 1962. During the July 1966–June 1973 period, Yeager had numerous high-profile assignments, including commander of the 405th Fighter Wing at Clark Air Base in the Philippines. While commander of the 405th, he flew 127 missions in South Vietnam.

Yeager earned numerous decorations and awards during his tenure in the USAF. He is a command pilot and has flown more than 10,000 hours in 155 different types of military aircraft. He was awarded the MacKay Trophy in 1948, the Collier Trophy in 1948, and the Harmon Trophy in 1954.

He was promoted to brigadier general effective 1 August 1969, with date of rank 22 June 1969. He retired on 1 March 1975. The Tom Wolfe book *The Right Stuff* portrayed Yeager in a very positive light and gave him much greater fame than all his flying exploits had previously achieved. He continued flying and has had a successful career in industry and as a products spokesman.

Steve Pace

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Yom Kippur War (October War)

Arab-Israeli conflict that occurred in October 1973 during Yom Kippur. After some 25 years of unparalleled air superiority in the Middle East, the Israeli Air Force (IAF) found itself dangerously vulnerable during the opening days of the Arab-Israeli October War. Egyptian and Syrian mobile SA-6 Gainful surface-to-air missiles (SAMs) limited the IAF's ability to support ground forces. The SA-6s took a heavy initial toll of Israeli aircraft because their electronic countermeasures (ECM) equipment was ill-suited to the frequency-hopping SA-6. Losses of Israeli McDonnell Douglas F-4Es prompted the United States to transfer a number of U.S. F-4Es from Europe to the Israelis, provoking Arab claims that U.S. pilots were flying combat missions on behalf of Israel.

Prompt Israeli ECM development efforts limited the SA-6's effectiveness. IAF aircraft then turned to Israeli ground operations, which regained large portions of the Golan Heights, the Sinai, and portions of Egypt and surrounded the Egyptian Third Army.

The October War influenced the evolution of aerial warfare. It was the first post-Vietnam conflict that relied heavily upon electronic warfare, especially SAM suppression. It led to a critical diplomatic confrontation between the United States and Soviet Union, linking regional tactical warfare with global strategic dynamics. It created the mistaken image of the importance of global aerial resupply, as the vaunted U.S. airlift to Israel did not even begin until 14 October, the day after the Israelis had reversed the tide of battle. The war ultimately damaged the reputation of the IAF as invincible, which contributed to Syria's willingness to fight Israel again in 1982.

Robert S. Hopkins

See also

Defense Suppression; Electronic Warfare; Israeli Air Force; Israel–Middle East Conflicts; Israel–Middle East Wars; NICKEL GRASS; Syrian Air Force

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Y-Service

Units that engage in the interception and exploitation of the patterns and substance of an enemy's low-grade signals traffic. Intelligence gained through the Y-service is typically used in the reconstruction of the enemy's order of battle and movements; however, it also provides important strategic intelligence. For example, on 20 May 1942 the Royal Air Force Y-service in North Africa learned that the total amount of enemy aviation fuel in the whole of Libya was only a paltry 3,283 tons.

This information enabled the RAF to gauge the effect of its interdiction campaigns and helped to predict enemy combat capability. More important to operations was the interception of enemy radio messages that contained intelligence on the locations of enemy units, early warnings of enemy air raids, as well as enemy tactics. This intelligence was intercepted, interpreted, passed along to the group controller and to Headquarters Northwest African Tactical Air Force, and aided in focusing Allied airpower against the most profitable targets.

Brad Gladman

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Z

Zeppelin, Ferdinand Von (1838–1917)

Airship pioneer. As an army officer during the nineteenth century, Graf (Count) Ferdinand von Zeppelin had observed balloons during the U.S. Civil War. Upon retirement he turned his energies to the development of airships for military use. Struggling with delays occasioned by lack of funds and the destruction of his ship by fire, Zeppelin eventually sparked the imagination and national pride of the German people. He was able to hang on, and a number of his rigid airships were built for the army and navy prior to the outbreak of war.

Zeppelins became famous during the raids on England during the years 1915–1918, but by this time the count had turned his attention to the development of the *Riesenflugzeug* (giant aircraft) that would, in company with the Gothas, succeed his airships as the primary bomber against England in the last year of the war. His name will forever be synonymous with the great airships of World War I.

James Streckfuss

See also

Airships

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Zero-Length Launcher

Rocket system designed to reduce the vulnerability of tactical air forces to airfield attacks, especially nuclear strikes. The zero-length launcher (ZEL) comprised a rocket-assisted takeoff system for fighter aircraft developed by the USAF during the 1950s. The ZEL system was designed to allow aircraft to take off from a mobile truck-mounted ramp or from a fixed ramp in a hardened aircraft shelter. This capability would allow aircraft to be launched even if the runways at an airfield had been damaged. The ZEL system was designed to ensure survival of the fighter force through protection (in the hardened shelters) or dispersal (atop the truck-mounted system). A similar launch system was used on the operational Matador, Mace, Regulus (ship- or submarine-launched), and Snark cruise missiles.

The ZEL system was successfully tested on Republic F-84G and North American F-100D fighters, but enough operational concerns existed that the capability was never deployed. The West German Bundesluftwaffe sponsored ZEL experiments with a Lockheed F-104G in the mid-1960s but did not develop an operational capability. The USAF also developed a complementary alternative landing system for use if airfield runways were too damaged for landings. This mat-landing (MAL) system used the standard aircraft tailhook and a mobile ground system composed of an arresting cable and a pneumatic mat for cushioning that could be deployed in any open field. The combined launch-and-recovery system was referred to as "ZELMAL." The MAL landing system was tested on several F-84G flights but was quickly abandoned due to physical stresses on the pilot. Although the ZELMAL effort was not successful, continuing USAF concerns over airfield vulnerability produced engineering designs that made airfields and aircraft more survivable and led to specialized aircraft designs, such as the swing wings on the General Dynamics F-111 and the V/STOL capabilities of the British and U.S. Harrier jumpjets.

Jerome V. Martin

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Zuckert, Eugene M. (1911–2000)

Prominent public servant in various capacities; secretary of the U.S. Air Force. Born on 9 November 1911 in New York City, Eugene M. Zuckert attended public elementary and high schools in suburban New York. After prep school he obtained a degree from Yale University in 1933, then entered the combined Yale Law School–Harvard Business School course sponsored by William O. Douglas. Zuckert became a member of the Connecticut and New York bars and eventually that of the District of Columbia.

In 1940, after a three-year stint an as attorney for the U.S. Securities and Exchange Commission, he became an instructor in government and business relations at the Harvard Graduate School of Business Administration, where he subsequently became assistant dean. While at Harvard he also served as a special consultant to the commanding general of the Army Air Forces in developing statistical controls.

It is rare when two leaders of very strong character and personality pose together with smiles and mean it. In this case it is true: Gene Zuckert and Curtis LeMay liked each other and got along well. (U.S. Air Force)

In 1944, Zuckert entered the U.S. Navy as a lieutenant (junior grade) and worked in the office of the Chief of Naval Operations, where he was assigned to the Navy's inventory-control program. In September 1945, he was released from the Navy to become executive assistant to the administrator of surplus property administration under W. Stuart Symington. When Symington became assistant secretary of war for air in February 1946, Zuckert became his special assistant.

With the passage of the National Security Act in 1947 and Symington's subsequent appointment as the first secretary of the Air Force, Zuckert took the oath as assistant secretary of the Air Force. His principal duties were in the field of management. In this capacity, he helped institute Symington's program of management control through cost control. Zuckert represented the Air Force in the formulation of the fiscal year 1950 budget, the first joint Army–Navy–Air Force budget in U.S. history.

According to Zuckert, the accomplishment that gave him the most professional satisfaction stemmed from President Harry Truman's directive in 1948 requiring the armed services to abolish segregation. Working with General Idwal H. Edwards, head of Air Force personnel, Zuckert oversaw implementation of the integration program. When he left as assistant secretary in February 1952 to become a member of the Atomic Energy Commission, he left an Air Force cost-control system that had established a new standard for sound business administration within the military establishment, and he secured a personal reputation as one of the top-flight young career officials in government.

In December 1960, Robert McNamara, President-elect John F. Kennedy's designated secretary of Defense, recommended to Kennedy that Zuckert be appointed Air Force secretary. Zuckert was nominated and confirmed in January 1961. With nearly six years of Air Force experience, he was well prepared for the duties of secretary of the Air Force. Zuckert was involved in the controversies associated with the B-70, Skybolt, and TFX (later the F-111) weapons systems and had direct participation in the Vietnam War. Both he and Air Force Chief of Staff General Thomas D. White opposed an administration decision to cut the B-70 bomber. Zuckert later admitted he erred in promoting the bomber because of its increasing vulnerability to enemy defenses.

The TFX was a tactical fighter-bomber designed and built for both the Air Force and Navy. In negotiations over the development of this weapon, Zuckert supported the administration, which wanted the plane, against the Air Force, which did not. In so doing, he strained his relationship with the Air Force and lost a measure of confidence. Zuckert often found himself as the man in the middle, at times supporting the Air Force against the secretary of defense and the administration. Both the Air Force and the secretary of defense agreed upon one of Zuckert's ideas, however: Project Forecast. This study, initiated in May 1963, was prompted by Zuckert's observation that the Air Force ought to take a look at the technologies that would have some bearing upon future aerospace military operations.

Shortly after Zuckert left office in September 1965, the Air Force instituted the Zuckert Management Award, given each year on 30 September to a general officer or high-level civilian for outstanding management performance.

He returned to the practice of law and headed the firm of Zuckert Scoutt and Rasenberger, where he stayed until retirement in 1988. He served as director of several small technically oriented companies and as a member of the board of Washington Gas Light and Martin Marietta Corporation. Zuckert died on 5 June 2000.

George M. Watson Jr.

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CONTRIBUTORS

Gregory Alegi
Italian Air Force Academy/LUISS
Rome, Italy

William Althoff
West Central,NJ

David C. Arnold, USAF
United States Air Force Academy
Colorado Springs, CO

Bruce Ashcroft
Air Education and Training Command
Randolph Air Force Base, TX

Albert Atkins
Embry-Riddle Aeronautical University/
University of Phoenix
Colton, CA

John H. Barnhill
Defense System Information Agency
Oklahoma City, OK

John L. Bell Jr.
Western Carolina University

Andy Blackburn
Author/Historian
Windsor, England

Carl Bobrow
National Air and Space Museum
Washington, DC

Horst Boog
Professor
Munich, Germany

Walter J. Boyne
Author/Historian
Ashburn Farms, VA

Squire Brown
Author/Historian
Dayton, OH

Robert Bunker
Institute of Land Warfare
Association of the United States Army
Washington, DC

Shawn Cafferky
University of Victoria

Donald Caldwell
Author/Historian
Lake Jackson, TX

Brian Carpenter
University of Tennessee

Michael S. Casey
Dean, Graceland University
Lamoni, Iowa

Gary Mason Church
Texas A&M University
Dallas, TX

Craig T. Cobane
Culver-Stockton College
Canton, MO

Wendy M. Coble
Naval Historical Center
Washington, DC

Kenneth Collinge
Historian
Trumbull, CT

Ann Cooper
Author/Historian
Beavercreek, OH

Major General Charles S. Cooper III,
USAFR (Ret.)
Author/Historian
Beavercreek, OH

Sherwood Cordier
Western Michigan University

Kazimiera J. Cottam
Independent Scholar
Ottawa, Ontario, Canada

Conrad Crane
Research Professor of Military Strategy
Strategic Studies Institute, U.S. Army
War College
Carlisle Barracks, PA

Thomas M. Culbert
Aviation Information Research
Corporation
Alexandria, VA

Douglas G. Culy
Author/Historian
Tempe, AZ

Kev Darling
Author/Historian
United Kingdom

R.E.G. Davies
Curator of Transport
National Air and Space Museum
Washington, DC

Richard DeAngelis
Fairfield University
Fairfield, CT

Scott R. DiMarco
Director of Library Services
Herkimer County Community College
Kerkimer, NY

David Dorando
Western Carolina University
Cullowhee, NC

Major Braxton R. Eisel, USAF
The Pentagon
Washington, DC

Jeffrey A. Engel
University of Wisconsin
Madison, WI

Lieutenant Colonel John T. Farquhar, USAF
United States Air Force Academy
Colorado Springs, CO

Susan Hayes Fischer
Author/Historian
Indianapolis, IN

Santiago Flores
Author/Historian
Tijuana, Mexico

Paul E. Fontenoy
Curator of Maritime Research and Technology
North Carolina Maritime Museum
Beaufort, NC

Lieutenant Colonel Bert Frandsen, USA (Ret.)
Author/Historian
Auburn University
Montgomery, AL

Colin Fries
National Aeronautics and Space Administration

Rafael J. Garcia Jr.
Author
Alexandria, VA

Major Paul G. Gillespie, USAF
United States Air Force Academy
Colorado Springs, CO

Brad Gladman
University of Calgary
Calgary, Alberta, Canada

Kevin Gould
American Military Institute
Manassas, VA

John F. Graham
University of North Dakota
Grand Forks, ND

Mark Grandstaff
Brigham Young University
Provo, UT

James L. Green
Author/Historian
Silver Spring, MD

First Lieutenant Troy Hammond, USAF
Whiteman Air Force Base, MO

William Hartley
University of Tennessee
Knoxville, TN

Brian Head
Warner Robins, GA

William Head
Chief WR-ALC Office of History
Robins Air Force Base, GA

Henry H. Holden
Author/Historian
Randolph, NJ

Robert S. Hopkins III
Author/Historian
Oak Creek, WI

Renjia Hua (deceased)
Professor, Air Force Command College
People's Repubic of China

J. D. Hunley
Former Chief Historian
Dryden Flight Research Center, NASA
Greenbelt, MD

David Isby
SPARTA, Inc.
Washington, DC

B. M. Jain
Rajasthan University
Jaipur, India

Dennis Jenkins
Author/Historian
Cape Canaveral, FL

Frederick A. Johnsen
Historian
Tehachapie, CA

Randy Johnson
Dean, College of Aviation
Embry-Riddle Aeronautical University
Daytona Beach, FL

Stephen B. Johnson
University of North Dakota
Grand Forks, ND

Major Ben Jones, USAF
United States Air Force Academy
Colorado Springs, CO

Mark Kahn
National Aeronautics and Space Administration
Washington, DC

Stanley Kandebo
Aviation Week and Space Technology
New York, NY

Jeremy R. Kinney
Curator for Aero Propulsion
National Air and Space Museum
Washington, DC

Gary Kuhn
Latin American Aviation Historical Society

William M. Leary
University of Georgia
Athens, GA

W. David Lewis
Auburn University
Auburn, AL

James K. Libbey
Embry-Riddle Aeronautical University
Daytona Beach, FL

Michael Little
Offutt Air Force Base, NE

Alwyn T. Lloyd
Boeing Company
Bellevue, WA

D. Y. Louie
Aviation Enthusiast
Statesboro, GA

Jerome Martin
Peru State College
Peru, NE

Jeffrey J. Matthews
University of Puget Sound
Tacoma, WA

Birch Matthews
Author/Historian
Rolling Hills Estates, CA

Emerson Thomas McMullen
Georgia Southern University

Phillip Meilinger
Author/Historian
Patomac Falls, VA

George Mellinger
Author/Historian
Sioux Falls, SD

Malcolm Muir
Austin Peay State University
Clarksville, TN

Frank Nickell
Southeast Missouri State University
Cape Girardeau, MO

Stéphane Nicolaou
Curator
Musée de l'Air et de l'Espace
Paris, France

Guy Noffsinger
Author/Historian
Defense Intelligence Agency School
Washington, DC

Cynthia Clark Northrup
University of Texas
Arlington, TX

John Andreas Olsen
Royal Norwegian Air Force Academy
Oslo, Norway

Mark A. O'Neill
Tallahassee Community College
Tallahassee, FL

Steve Pace
Author/Historian
Tacoma, WA

James D. Perry
Science Applications International
Corporation
McLean, VA

Lieutenant Colonel James M. Pfaff, USAF
Marysville, IL

David Pluth
Historical Research
Chaska, MN

Raymond L. Puffer
Historian
Air Force Flight Test Center
Edwards Air Force Base, CA

Edgar F. Raines
U.S. Army Center of Military History
Washington, DC

Rebecca C. Raines
U.S. Army Center of Military History
Washington, DC

Peter Rainow
Author/Historian
San Mateo, CA

David Rezelman
Author/Historian
Virginia Beach, VA

Daniel Ruffin
Bellbrook, OH

Colonel Steven A. Ruffin, USAF
Bellbrook, OH

Frank Schumacher
University of Erfurt
Erfort, Germany

Noel Shirley
Author/Historian
San Jose, CA

Jerry D. Snead
Auburn University
Auburn, AL

J. J. Snyder
Agricultural Aviation Consultant
Kingsburg, CA

Christopher H. Sterling
Professor of Media and Public Affairs and
of Telecommunications
George Washington University
Washington, DC

Erich Streckfuss
Cincinnati, OH

James Streckfuss
President
League of World War I Aero Historians
Cincinnati, OH

Rick W. Sturdevant
Deputy Director of History
Headquarters Air Force Space Command
Colorado Springs, CO

William Suit
Wright-Patterson Air Force Base
Dayton, OH

Guillaume de Syon
Albright College
Reading, PA

Christopher Terry
President and CEO
Canada Science and Technology Museum
Corporation
Ottawa, Ontario, Canada

Roger M. Thomas
Jacksonville University
Jacksonville, FL

Warren Thompson
Author/Historian
Germantown, TN

Earl H. Tilford Jr.
Grove City College
Grove City, PA

William F. Trimble
Auburn University
Auburn, AL

Diane Truluck
Warner-Robins Air Logistics Command
Robins Air Force Base, GA

Frank E. Watson
Richmond, VA

George M. Watson Jr.
Chief, Special Projects
Air Force History Support Office
Bolling Air Force Base
Washington, DC

Captain Grant Weller, USAF
United States Air Force Academy
Colorado Springs, CO

Colonel Darrel Whitcomb, USAF (Ret.)
MARC Corporation
Fairfax, VA

Thomas Wildenberg
Author/Historian
Silver Spring, MD

James H. Willbanks
U.S. Army Command and Staff College
Fort Leavenworth, KS

Mark D. Witzel, USAF
United States Air Force Academy
Colorado Springs, CO

Daniel Worthington
Harpweek LLC
Norfolk, VA

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