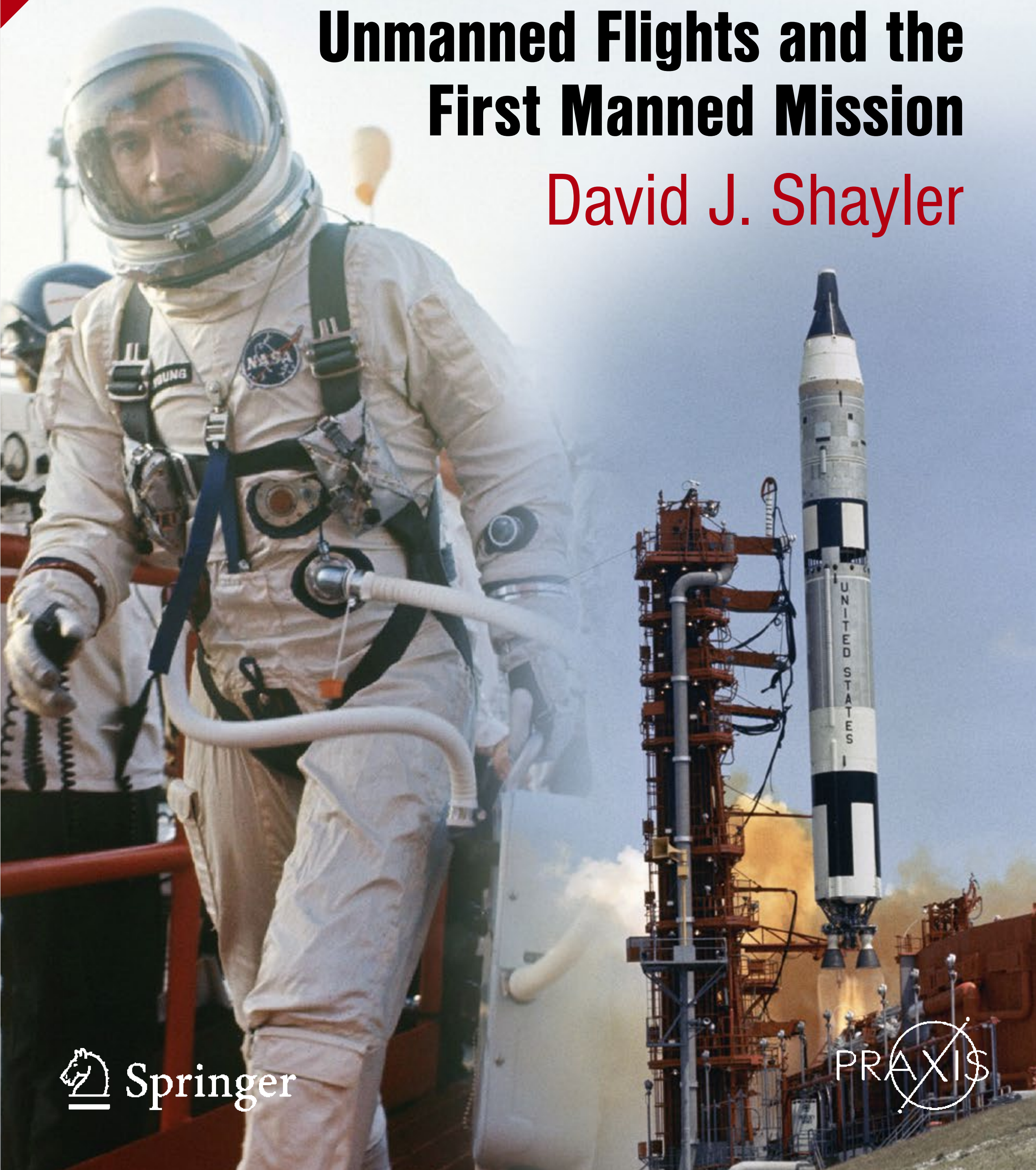
PIONEERS IN EARLY SPACEFLIGHT

Gemini Flies!

Unmanned Flights and the First Manned Mission

David J. Shayler



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Front cover: The operational era of Project Gemini began on April 8, 1964 with the launch of the unmanned Gemini 1 from Pad 19, Cape Kennedy, Florida, atop the two-stage Titan II launch vehicle (right). This was followed less than one year later by the first manned flight, Gemini 3, nicknamed '*Molly Brown*' by Command Pilot Virgil I 'Gus' Grissom and Pilot John W. Young. Young is seen here striding towards the elevator at the launch pad to take up his place in the spacecraft on March 23, 1965 (left). (Courtesy Ed Hengeveld).

Back cover: (Right) Between Gemini 1 and Gemini 3, the unmanned Gemini 2 flew a sub-orbital test of the spacecraft's heat shield in January 1965, clearing the way for manned operations. Here, the spacecraft's re-entry module is seen on the recovery carrier after being retrieved from the ocean (Courtesy Ed Hengeveld).

(Left) The cover for the next book in this series covering the four-day mission of Gemini 4 in June 1965, which included America's first experience of extravehicular activity (more commonly known as a spacewalk).

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Author's Preface

Unfortunately, I missed the whole of the Gemini program as it was happening. In 1965, as a ten-year-old in primary school and a veteran of such children's TV space programs as *Fireball XL-5*, *Space Patrol* and the 'original' *Doctor Who*, I was too young to appreciate the news bulletins and newspaper headlines of the real space program. The earliest memory I have of an actual event to do with space is the Monday morning school assembly of January 30, 1967, during which a prayer was said for the Apollo 1 astronauts who had died the previous Friday. My next memory, this time from a spaceflight, was of the black and white TV transmissions from Apollo 7 in October 1968. Then, from the launch of Apollo 8 on December 21, 1968 onwards, I was hooked and never looked back. Since then, there has not been a day that I have not thought about the space program. By 1968, I was in secondary school – now a 13-year-old – and we were given a school project to complete for the end of term. For me the choice was easy – I chose Apollo.

While researching the subject, one of the books I found in the school library was Kenneth Gatland's *The Manned Spacecraft Pocket Encyclopedia of Space Flight in Colour* (Blandford, 1967). Within its pages, I eagerly read about the Gemini missions for the first time. Then, during the Apollo 8 mission, I learned more about the first spaceflights of Frank Borman and Jim Lovell on Gemini 7 just before Christmas 1965 and about Lovell's return to space almost a year later with Edwin E. 'Buzz' Aldrin (as he was known then) on Gemini 12, which ended the short program. Gemini fascinated me, both in what it had achieved in such a short timescale from concept to completion and in what was promised, but never delivered, by the military and civilian space programs.

A few years later, as a keen model maker, I was the proud owner of Revell's 1/48th scale Mercury and Gemini spacecraft, a larger 1/24th scale Gemini model and a 1/12th scale representation of 'a Gemini astronaut' performing EVA. There was even a board game based upon Gemini and I still have it in my collection. The Waddington Company had produced a game called '*Blast-off,*' part of which involved rendezvous and docking in orbit using little plastic models of the Gemini and Agena spacecraft. It was a game with which I had hours of fun. So, even though I had missed the 'real' Gemini missions, I had become fascinated by this series of ten manned missions which were deemed essential to

Apollo's chances of successfully reaching the Moon. Over the past 50 years that interest has never really gone away, it just became diverted a little.

Since the late 1960s, I have amassed a fair collection of books, reports, cuttings and images, but have remained surprised by the relative lack of information on Gemini over the years. I had acquired Gus Grissom's *Gemini*, the official NASA history *On the Shoulders of Titans* and the official chronology of the program, as well as the more personal accounts by Mike Collins (*Carrying the Fire*) and Buzz Aldrin (*Return to Earth*). Each year, I eagerly awaited the next piece to the jigsaw, hoping for more dedicated books on each mission, but throughout the 1970s and into the 1990s those titles never appeared. It was not until 1988 and my first visit to NASA Johnson Space Center's History Office and the archives at Rice University, Houston, that I discovered the wealth of information just waiting to be researched. At that time, I was researching the topics of space suits and EVA operations and had the good fortune to interview Gene Cernan about his experiences on Gemini 9. Searching the 'retired' Gemini archives at Rice (which were subsequently moved to NARA in Fort Worth in 2000) simply amazed me and I eagerly delved deeper, vowing to "write a book on the subject" one day. That had to wait until 2000 when I finally secured a contract, from Springer-Praxis, to produce a summary of the Gemini program, which was published the following year as *Gemini: Steps to the Moon*. Although this was great fun to write, I always felt that I could have done more with the accounts of each mission, but there was simply not enough room in one volume to do this justice. For the next fifteen years the idea was shelved as other projects took over.

Then, in 2014, my good friend and colleague Colin Burgess embarked upon a series of books featuring the six manned missions of Project Mercury. Towards the end of that series, Colin told me that he was not contemplating continuing the series beyond Mercury and, eager to see the series continue into the next stage, I decided to take up the mantle and attempt to write about each Gemini mission in more detail than in my earlier book. Even with the long-duration Gemini 7 mission combined with short duration Gemini 6 rendezvous mission, this would still mean nine titles, or more than a third of my total output from the previous 25 years! As daunting as this might seem, Springer was fortunately keen on the idea and would support the venture, with the books appearing under their *Pioneers in Early Spaceflight* series. The gauntlet was cast, but it was an exciting idea and a quest I was eager to embark upon.

I had decided early on to incorporate the unmanned missions of Gemini 1 and 2 into this first title in the series detailing the three-orbit test flight of Gemini 3 (or '*Molly Brown*'). Each title would complement, yet not replace, the information originally published in *Gemini: Steps to the Moon*. These new works will rely heavily on the air-to-ground commentary recorded during each mission, as well as official pre- and post-flight reports, various newspaper accounts of the day, contemporary sources and, wherever possible, extracts from interviews or information provided by those who participated in the program. I had also decided to expand on information unique to the mission being flown, so in this book on Gemini 3, details of the spacecraft's maneuvering system and heat shield are explained. The fledgling story of EVA will be introduced in the Gemini 4 title, while the challenge of long-duration flight will be covered in the Gemini 5 and 7 titles. Next comes mastering the techniques of rendezvous and docking, which will feature in the

Gemini 6 account and Gemini 8 title. Overcoming other difficulties to develop 'routine' operations in Earth orbit will be discussed in the final titles covering Gemini 9 through 12.

Gemini was a pivotal program, not just for Apollo or American spaceflight in general, but in the early history of human spaceflight. So much was learned during those few short months of 1965 and 1966, much of which was directly relevant to so many programs that followed long after Apollo ended and continues to be so for those yet to fly. The story needs to be told, step by step, mission by mission, of a program that followed in the wake of the pioneering missions of Mercury and created the confidence to embark upon Apollo and beyond.

As the title suggests, this volume explains how *Gemini Flies* during the two unmanned missions which preceded the historic flight of Gus Grissom and John Young in *Molly Brown*, the first manned mission that completed the testing phase of Gemini so successfully. The official testing may have ended with Gemini 3, but this was only the very start of the story and a remarkable journey. I may have missed Gemini real-time, but I am sure that writing this series will address that lament.

David J. Shayler, FBIS
Council Member, British Interplanetary Society,
Director, Astro Info Service Ltd.,
www.astroinfoservice.co.uk
Halesowen, West Midlands, UK
August, 2017

Acknowledgements

In the acknowledgments of my earlier book on Gemini, I gratefully thanked the network of colleagues, space sleuths, historians and archivists who formed part of a global infrastructure of contacts, long before the existence of the world-wide-web. This global network of contacts fortunately continues to this day.

For this project in particular, I appreciate the continued support and assistance of Colin Burgess, for his fitting Foreword to the first book in this series and for his support in embarking on this journey through Gemini. Thanks also to David Harland, editor extraordinaire and author of the excellent *How NASA Learned to Fly in Space* (Apogee 2004), for his guidance towards a number of rare Gemini documents and archives, as well as to Michael Cassutt for further clarification of the intricacies of the NASA Astronaut Office of the mid-1960s. A special thanks to Ed Hengeveld and to Joachim Becker of *SpaceFacts.de* for providing the elusive Gemini images and for their unselfish support in enhancing the presentation of these volumes with those images.

The majority of images used in this book originate from NASA, various military service organizations, the author's own collection and those credited in the individual captions, unless specifically stated. However, despite extensive searches, I have been unable to determine the exact origins of some of the images. I would welcome any input to enable me to credit the appropriate source.

Over a period of fourteen years – 1988 through 2002 – I was fortunate to be able to visit and work within the History Offices of NASA JSC, the archives at NARA Fort Worth and the Universities in Houston at Clear Lake and Rice. I therefore once again express my heartfelt gratitude to the staff of the NASA History Office at JSC, including, successively, Janet Kovacevich, Joey Pellerin and Asha Vasha, David Portree, Glen Swanson and more recently, John Uri. The History Office staff at Washington D.C., notably in the 1980s Lee Saegesser, latterly Steve Dick, Roger Launius and currently Bill Barry. Thanks to Shelly Kelly at the JSC History Archive, Clear Lake University and to Joan Ferry and staff at the Fondren Library, Rice University, where the Gemini collection was held up to the late 1990s until it was moved to NARA, Fort Worth, where Meg Hacker and Michael Wright continued to assist.

To the staff of the now discontinued Still Photo Archive at JSC (Mike Gentry, Lisa Vasquez, Debbie Dodds, Mary Wilkinson and Jody Russell) who were always helpful in answering imagery queries, as were Margaret Persinger at KSC and Gwen Pitman at NASA in Washington. Another much-missed research archive is the former JSC Audio Library and here thanks go to former employees Diana Ormsbee and Pete Nubile. At KSC, help has also been forthcoming from Archivist Kay Grinter, the Center Historian Ken Nail and Elaine Liston.

I am especially indebted to former Gemini Flight Controller Erik 'Dutch' von Ehrenfried for explaining some of the intricacies of Mission Control of the mid 1960s, as well as providing some elusive documents, rare images and words of encouragement.

As always, I must thank the support and encouragement of the staff and Council of the British Interplanetary Society in London, especially the former Executive Secretary Suszann Parry and her successor Gill Norman. Thanks also to the Library and History Committees for access to the books, reports and releases held in the wonderful resource of the Society's Library.

No Springer-Praxis title could exist without a word of thanks and appreciation for the support, insight and encouragement of Clive Horwood of Praxis Publishers. Appreciation also goes to his team of Proposal Reviewers and to Jim Wilkie for his excellent artistry in converting my original cover ideas to the masterpiece you see here. Jim's skills in every cover he creates makes each book a leading attraction on the old-fashioned book shelf or in the more modern social media platforms and web pages. Thanks also to Maury Solomon and her assistant Hannah Kaufmann at Springer New York for the belief and support they show with each title.

I send a heartfelt thank you once again to my Project Editor and brother Mike Shayler, whose editorial skills and sheer enjoyment of the English language always manages to evolve my scribbles and so-called final drafts into so much more. These books are a whole lot better because of Mike's wordsmith genius. Thanks also go to my 88-year-old mother, Jean, who still, after all these years, enthusiastically supports her family in whatever they do and displays the grit and determination to master even more computer and scanning skills to stop her from "feeling bored" in retirement.

They say every good man has a great woman behind him. I can certainly vouch for that in expressing my love and indeed sympathy to my wonderful wife Bel, who continues to "put up" with my book projects instead of contemplating "a quiet retirement," whatever that may mean! Finally, to Shado, as energetic and intelligent as a two-year-old German Shepard can be, always eager to drag me away from the computer to engage in more important and exciting pastimes like throwing balls, or taking long walks. Who said book writing was easy?

To all a big thank you once again, for allowing me to devote hours of attention to scribbling my accounts of human spaceflight for those who created the history, those who remember and witnessed it and those who can only learn about what has gone before but will hopefully be there to experience what is to come.

DEDICATION

To the NASA Astronaut Team
of
1959-1966

And specifically, to the first astronauts to fly Gemini:
Virgil I. 'Gus' Grissom (1926-1967)
&
John W. Young (1930-2018)

Also to the memory of
Group 3 pilot astronaut
Theodore C. Freeman (1960-1964)
A leading contender for an early Gemini assignment

And finally

To all the members of the Project Gemini ground team,
each of whom played their part in designing, developing, building,
managing, testing, processing, controlling and supporting
parts of the whole that finally allowed *Molly Brown*
to fly and fly well

…

As this book was being edited, news came through of the death, aged 101, of suit
technician Joe Schmitt, who had suited up every American astronaut from Alan Shepard
in May 1961 to the crew of STS-5 in November 1982.
Then, just a few weeks later, came the sad news that Gemini astronaut
Richard F. ('Dick') Gordon Jr. (BUp Pilot Gemini 8, Pilot Gemini 11)
had passed away at the age of 88.
This book therefore is also dedicated to Joe, as suit technician on all the Gemini
missions, and Dick, the original 'Space Cowboy',
with appreciation and sadness at their passing.

Foreword

As a spaceflight historian, author, and Project Mercury tragic, I had long aspired to write a series of books detailing each of the six flights in the Mercury program which carried the first astronauts on America's pioneering space missions. After some consultation with the good folks at Springer-Praxis, they agreed to publish the series and work began on the first volume, *Freedom 7: The Historic Flight of Alan B. Shepard, Jr.*, which was released in 2014. The six-book series was eventually completed two years later with the publication of the book on Gordon Cooper's 22-orbit flight aboard the *Faith 7* spacecraft.

It was around this time that my long-time friend and writing colleague David Shayler asked if I was planning to continue the series into the next program phase, by researching and writing similar books on each of the ten missions that flew under the name Project Gemini. This was something I had not seriously contemplated, especially as I was moving on to other book projects. With that established, David asked for my permission to take over the reins and produce a whole new series of books on the Gemini missions. I was more than happy to agree, knowing through long experience that David was eminently capable of producing an outstanding series of interesting and informative books. Especially as he would be able to explore and write about each flight and the astronauts involved in far greater depth than was possible when he wrote his seminal Springer-Praxis book, *Gemini: Steps to the Moon*, back in 2001 (republished in 2009).

The prime objective of the Mercury program was to test and establish whether a human being could survive the many and largely unknown rigors of space travel: the dynamics of lift-off, massive acceleration forces and the perils associated with the white-hot re-entry phase. In other words, that space travelers could live and work in space on missions of increasing length and complexity. Project Gemini had its origins in 1961 and was undertaken to provide a necessary bridge between Project Mercury and Project Apollo, which would hopefully place the first American astronauts on the Moon's surface before the end of the 1960s, as pledged by President John F. Kennedy.

Through its Gemini program, NASA would seek to develop and refine crucial techniques while conducting a series of low Earth orbital (LEO) missions. These would be flown between 1965 and 1966 in an incredible period of activity, which saw – on average – the launch of one crewed Gemini mission every two months. It was an outstanding feat of science and technology that saw the United States rapidly outstrip the efforts of the Soviet Union in the monumental Cold War race to the Moon.

As with Project Mercury, certain objectives were laid down for the more sophisticated two-man Gemini missions. These were:

- To demonstrate the endurance of humans, equipment and spacecraft systems during space missions extending up to a maximum of two weeks, sufficiently covering the eight days it would take for an Apollo journey to the Moon and back.
- To carry out rendezvous and docking with another orbiting vehicle and to practice maneuvering techniques of the combined spacecraft using the propulsion system of the target vehicle.
- To effect Extra-Vehicular Activity (EVA), or spacewalks, by exiting the confines and protection of the Gemini craft and to evaluate an astronaut's ability to perform manual tasks in the weightlessness of raw space.
- To enable engineers, controllers and astronauts to perfect techniques associated with atmospheric re-entry and touchdown at a pre-selected location.

Without any doubt, many people performed with magnificence and contributed to the amazing success that was Project Gemini. It was a truly momentous and enthralling period in spaceflight history. From a personal point of view, I can still vividly recall many times in my youth when I would be hunkered down in my bed well past the midnight hour, listening intently and with some trepidation to each Gemini launch on my little transistor radio. They were exciting times indeed.

It goes without saying that I am delighted David has decided to undertake this latest and important series project encompassing each of the twelve missions in chronological order. I know that he will not only provide a great and (as always) authoritative narrative, but one that all readers and historians will enjoy. This exciting story starts here with the two unmanned flights of Gemini 1 and Gemini 2, followed by the first manned flight of the series, the three-orbit mission of Gemini 3, more commonly known as *Molly Brown*. Flight by flight, with the Gemini 7 and 6 missions covered in one volume, the series will follow the trials and triumphs of Gemini from the first lift-off in April 1964 to the final splashdown thirty-one months later in November 1966. I know this will prove to be an exciting and interesting venture for you David.

Like so many others, I look forward to the day when I will have nine new and exciting books on my bookshelf as a tribute to your amazing work, talents, persistence and your dedication to continuing to record the absorbing history of human space exploration.

Colin Burgess,
Bangor, Australia
2017

Acronyms and Abbreviations

Distances used in the text (As per The Concise Oxford Dictionary, New Edition, 2003)

Mile (or statute mile)
A unit of linear measurement equal to 1,760 yards or 5,280 feet (1.609 kilometers)

Nautical Mile (or sea mile)
A unit of measurement of approximately 2,025 yards or 6,075 feet (1.852 kilometers).

Kilometer
A metric unit of measurement equal to 1,000 meters (approximately 0.62 miles).

Apogee
A point in an orbit where an object (in this case a spacecraft) is furthest from the Earth (the opposite of perigee).

Perigee
A point in an orbit where an object (in this case a spacecraft) is nearest to the Earth (the opposite of apogee).

Orbit
The path of a spacecraft under the influence of gravitational forces beginning and ending at a fixed point in space after completing 360 degrees of travel around a celestial body, in this case Earth. This, for clarity, is the term used in these books.

Revolution
A circuit of a celestial body, in this case the Earth, which begins and ends at a fixed point on the surface of that body. As Earth is *revolving* in the same direction as the trajectory of the orbital spacecraft (Gemini), this point in space moves further ahead, requiring the spacecraft to ‘catch-up’ and resulting in more than 360 degrees of travel in an orbit. Therefore, a revolution is about six minutes longer than an orbit. In the early days of the space program, the number of circuits around the Earth was originally given in orbits. Then Mission Control started to quote revolutions, which became confusing to the general public, so they switched back again. Today, the word ‘orbit’ continues to be the most commonly used term in recording the number of circuits of a spacecraft around the Earth (or other celestial body).

A word on Zero-g, or Weightlessness, or Microgravity

A long-term misnomer in space exploration concerns the terms ‘zero-g’ or ‘weightlessness.’ The motions of astronauts floating in space were described (for clarity, but incorrectly) as being in zero-gravity (or zero-g) or having no weight (weightlessness). In fact, there are gravitational forces at play in space and a more correct description would be ‘microgravity’, as those forces are there but are mostly negated by orbital motion. As an object (spacecraft) travels in the cosmos, apparently following a straight-line, it is also ‘pulled’ by the gravitational forces of celestial bodies. A spacecraft circulating around a celestial body is still being pulled towards it by gravity, but if that spacecraft is traveling fast enough, it achieves a state of continuous free-fall around that body. Thus, it is held in ‘orbit’ by a fine balance of motion and gravity until it either accelerates further to raise its orbit and achieve escape velocity, or decelerates to a lower orbit to begin the re-entry and decent to a landing.

A note on Gemini designations

The Gemini missions have been identified in different ways, including those which flew solo without an Atlas-Agena target and those which included an Atlas-Agena launch. Normally, the launch vehicle was also added to the description, thus: Gemini-Titan (abbreviated as GT-#) or with an Agena vehicle as Gemini-Titan-Agena (abbreviated as GTA-#) The flight numbers were often designated in Arabic numerals as Gemini 1 through 12, although NASA documentation of the time and the official accounts of the program used the Roman numerals I, II, III, IV, V, VII, VI, VIII, IX, X, XI and XII. To complicate this further, the original Gemini 6 and 9 missions were rescheduled and adopted the designations Gemini 6A (VI-A) and Gemini 9A (IX-A) when they flew. In these books, for clarity, the Arabic identification system has been adopted in most instances.

AC	Alternating Current
ACE	Attitude Control Electronics
ACME	Attitude Control Maneuver Electronics
AFB	Air Force Base
ANT	Antigua (secondary tracking station)
ASC	Ascension Island (secondary tracking station)
BDA	Bermuda (PRIMARY tracking station)
BECO	Booster Engine Cut-Off
BEF	Blunt End Forward (rear of the spacecraft facing the direction of flight)
CAL	Point Arguello, California (PRIMARY tracking station)
Cape	Cape Kennedy/Canaveral, Florida
Capcom	Capsule Communicator
CG	Center of Gravity
CNV	Canaveral (Cape Kennedy) Launch Control Center, Florida (PRIMARY tracking station)
COSPAR	Committee on Space Research (International)
CRO	Carnarvon, Australia (PRIMARY tracking station)
CSQ	*Costal Sentry Quebec* (PRIMARY tracking ship)
CTN	Canton Island (secondary tracking station)

CYI	Grand Canary (PRIMARY tracking station)
DAS	Data Acquisition System
DC	Direct Current
DCS	Digital Command System
DEI	Design Engineering Inspection
DOD	Department of Defense
ECS	Environmental Control System
EGL	Eglin Field, Florida (secondary tracking station)
ETR	Eastern Test Range, Florida
FAI	Fédération Aéronautique International
FDI	Flight Director Indicator
FIDO	Flight Dynamics Officer
g	Gravity (g) force
G&C	Guidance and Control
GBI	Grand Bahamas Island (secondary tracking station)
GET	Ground Elapsed Time
GLV	Gemini Launch Vehicle (Titan II)
GMT	Greenwich Mean Time (UK: Universal or 'Zulu' Time)
GMS	Gemini Mission Simulator
GPO	Gemini Project Office
GSFC	Goddard Space Flight Center (secondary tracking station)
GT	Gemini-Titan (launch vehicle)
GTA	Gemini-Titan-Agena (launch vehicle)
GTK	Grand Turk Island (secondary tracking station)
GYM	Guaymas, Mexico (PRIMARY tracking station)
HAW	Kauai, Hawaii (PRIMARY tracking station)
HF	High Frequency
HOU	Mission Control Center, MSC, Houston, Texas (PRIMARY tracking station)
IGS	Inertial Guidance System
IMU	Inertial Measurement Unit
IVI	Incremental Velocity Indicator
KNO	Kano, Nigeria, Africa (secondary tracking station)
LC	Launch Complex
LTV	Ling-Temco-Vought
MA	Mercury-Atlas
Max Q	Maximum Dynamic Pressure
MCC	Mission Control Center (HOU/Houston)
MDF	Mild Detonating Fuse
MDS	Malfunction Detection System
MECO	Main Engine Cut Off
MET	Mission Evaluation Team

MISTRAM	MISsile TRAcking Measurements
MOL	Manned Orbiting Laboratory (USAF)
MR	Mercury-Redstone
MSC	Manned Spacecraft Center (Houston, Texas)
MSFN	Manned Space Flight Network
MTR	Module Test Review
MUC	Perth, Australia (secondary tracking station) – used the same Callsign as former Mercury station at Muchea, Australia
NADC	Naval Air Development Center
NASA	National Aeronautics and Space Administration
NASCOM	NASA COMmunications
OAMS	Orbital Attitude and Maneuvering System
PAO	Public Affairs Officer
PCM	Pulse Code Modulation
POISE	Panel On In-Flight Scientific Experiments
PRE	Pretoria, South Africa (secondary tracking station)
R&R	Rendezvous and Recovery
RCS	Re-entry Control System
RGS	Radio Guidance System
RKV	*Rose Knot Victor* (PRIMARY tracking ship)
RR	Roll Rate
RRS	Retrograde Rocket System
RSS	Reactant Supply System
RTK	*Range Tracker* (secondary tracking ship)
SECO	Second Stage Engine Cut-off
SEF	Small End Forward (nose of spacecraft facing the direction of flight)
SEP	SEParation (from Titan booster)
SFRRB	Spacecraft Flight Readiness Review Board
SPADATS	SPAce Detection And Tracking System (USAF)
SST	Spacecraft Systems Tests
STG	Space Task Group
T	Terminal countdown either before (T-/minus/or down) or after (T+/plus/or up) lift-off
TAN	Tananarive, former Malagasy Republic now Madagascar (secondary tracking station)
TETS	Thursday Evening Tanking Society
TEX	Corpus Christi, Texas (PRIMARY tracking station)
UHF	Ultra High Frequency
WETS	Wednesday Evening Tanking Society
WHS	White Sands, New Mexico, (secondary tracking station)
WLP	Wallops Island, Virginia (secondary tracking station)
WOM	Woomera, Australia (secondary tracking station)

Prologue
Molly Brown is on her way

"It looks nice"
Gus Grissom upon entering orbit.

March 23, 1965. Launch Complex 19, Cape Canaveral, Florida

> "*This is Gemini Control. T–2 minutes and counting. [with] a cross conversation going on between Gus Grissom and John Young on the various light positions. Everything is in a go condition… T–1 minute and 20 seconds… This is Gemini Control,"* reported Public Affairs Officer (PAO) Paul Haney. *"We're at T–1 minute, T–60 seconds and counting."* The first manned flight of a Gemini spacecraft was about to begin as Haney continued to check off the final seconds in the long count. *"T–45 seconds and counting. The range [is] holding a final status check, T–30 seconds. Recorders have gone to fast speed. Twenty seconds, fifteen seconds. Ten, nine, eight, seven, six, five, four, three, two, one, zero. Ignition…and we have a lift-off at 24 minutes after the hour. Rising very nicely. Cabin pressure climbing*." [1]

In his 1968 book *Gemini*, Grissom recalled these first few seconds of the mission. "There was a distant, muffled thunder ninety feet below our heavily insulated cabin. This was the split second during which our Malfunction Detection System had to warn me if something had gone wrong, and I had both hands on the ejection ring between my knees, ready to yank it hard if the MDS indicators on our instrument panel indicated we were in trouble." Seconds later, he glanced over to his pilot, who was not holding his ejection seat handle. [2] Despite his apparent trust in the rocket, Young was keeping a very close eye on the actions of his commander, as he related in an article following the flight: "I was watching you [Grissom] and if you'd pulled your ring a couple of times and nothing happened, I was sure going to yank mine hard." [3] It would be another 35 years before Young expanded upon his recollection of this, the first of seven rocket launches during his illustrious career. "Gus had flown MR-4 and knew what to expect, but I didn't have the foggiest notion." Young recalled that the noise in the cabin was not as loud as it had been in the simulator and that the lift-off was so smooth that it was not until he looked at the instrument panel that he realized they had left the pad. [4]

Just two seconds into the mission, Grissom reported that the onboard clock had started. This was followed ten seconds later by confirmation that the vehicle had begun its planned roll program and then by the pitch over at T+25 seconds.

On duty at Mission Control at the Capsule Communications (Capcom) console, Gordon Cooper acknowledged his fellow Mercury colleague's report with "*Roger. Pitch. You're on your way* Molly Brown." [5] It was important for Cooper to inform the crew of the actual lift-off, since it was so smooth, because if they had not been aware of the exact point of lift-off they would not have been prepared for the possibility of activating one of the more critical abort options, which occurred right at that time.

By the 60-second mark of the mission, the Titan was moving at a speed of 658 mph (1,059 kph), with the two astronauts, tightly strapped into their couches, experiencing 2 *g* as the point of maximum dynamic pressure (Max Q) on the vehicle was surpassed. With all systems reported in good condition inside the vehicle and three chase planes taking images of the outside, Gemini 3 soared spaceward. Young later commented that he felt they were "really hauling the mail," as the Titan gained speed. They were traveling three times as fast as Grissom had experienced on his first launch on a Redstone rocket, less than four years earlier.

"You're on your way *Molly Brown*." The March 23, 1965 launch of Gemini 3, carrying astronauts Virgil I. 'Gus' Grissom and John W. Young on the first of the program's ten manned missions.

Just two minutes into the ascent, Gemini 3 was fast approaching 3,000 miles per hour (mph, or 4,828 kilometers per hour, kph), imparting 3.3 *g* on the crew, who reported they were still in fine shape. Everything looked "Green for Go" in the Gemini control center as Capcom Cooper reported to the crew: "*You're a little high on the flight plan, but no problem* Molly Brown."

At 2 minutes 35 seconds, Grissom reported "*Go*" for staging. The shutdown of the twin first stage engines was followed just four seconds later by second stage ignition and thrusting, before the spent first stage was separated. This is referred to as a 'Fire in the hole'. For those few seconds the *g* loads eased, before building up again at three minutes into the mission as *Molly Brown*, perched on top of the Titan II second stage, was moving at a velocity of 6,500 mph (10,461 kph) and climbing fast.

Back on the ground, Mission Director Chris Kraft gave the crew a tentative "Go," but there was very little chatter from the two astronauts, who simply marked off the milestones in their flight plan as *Molly Brown* streaked space-wards.

Cooper: "*Looking good*."

Grissom gave a laugh in return and very calmly reported that they were starting to steer. They were flying a missile.

Grissom: "*Horizon comes right into view,*" he exclaimed as the vista caught his attention. "*Look at that horizon,*" he added, briefly admiring the view outside the window right in front of him.

At Ground Elapsed Time (GET) 4 minutes 35 seconds, *Molly Brown* was travelling at 12,000 mph (19,312 kph) and recording 3.5 *g*. The Flight Dynamics Officer (FIDO) reported an "excellent steering on this vehicle," with the combination in the primary guidance phase all the way to orbit.

"*You can see the view real well,*" Grissom reported on the clarity of his window, adding, "*the nose* [of Gemini 3] *dropped below the horizon a little bit, now it's back up above*."

There was a little distortion in Grissom's reports, but all were in the affirmative as milestones were quickly passed as the ascent continued. PAO Paul Haney stated that he thought the distortion was due to the communications system.

At 5 minutes 20 seconds, it was reported that the vehicle was approaching second stage engine cut-off. Then, just fourteen seconds later at 5 minutes 34 seconds, Mission Director Chris Kraft told Cooper to inform Grissom that they were given a "Go for separation." At the PAO console, Haney commented that aboard *Molly Brown*, Grissom reported he was "*very happy about that.*" At 6 minutes 10 seconds into the flight, Grissom confirmed: "*Okay. We are separated.*" *Molly Brown* was in orbit. It took about 15 to 16 seconds to separate to a safe distance from the booster. Gemini 3 was in excellent shape as they passed over Bermuda.

Pilot John Young, who had been very quiet up to this point during ascent, came onto the communication loop to report that "*the attitude was on the ball at 18 degrees nose down.*" Cape Capcom replied with confirmation of their orbit at "*87 [miles] by 125 [miles].*"

Grissom had become the first person to return to space and confirmed to his rookie pilot:

> "*That horizon is right where they said it would be.*" Young, never a man to waste words, replied simply, "*Yes.*"

Capcom Cooper then asked Grissom "*Does it look better from there than on a ballistic flight?*"

Grissom replied, "*It looks nice.*"

....

Fast forward to June 3, 1965, where Grissom and Young revisited the mission details during their technical crew debriefing, in this instance the launch phase. [6]

Grissom noted that the instrumentation on the booster performed as he expected, the two engine lights went off when ignition was called and he noticed a slow drop in fuel and oxidizer pressure. "When we got our roll program, we got roll rate. [But] I could see the roll by looking at the sky also. After lift-off, I could look at the sky and tell we were climbing, too."

John Young noted that he did not get much cue from the *g* forces at lift-off: "It's real, real soft," he said. Grissom concurred. "Lift-off is real soft. At staging, the booster was stable, and when the RGS took over, [the] booster pitched down real smoothly. I could feel those engines gimbal or kick around. It was all very smooth. In fact, the whole flight was smooth."

Neither man could recall feeling the hold down bolts blow at lift-off, as Grissom said: "My cues at lift-off were Gordo [Cooper] calling it, and the clock starting to run at the same time. It was just seconds after that, that I glanced out the window, and I could tell that we were climbing." It was so quiet that Young felt the actual lift-off noise was lower than that he associated with the Ling-Temco-Vought (LTV) simulator. Grissom again concurred. "The noise level was a lot lower. It was a lot less that we had at Vought. [The Titan II] is a real quiet bird." However, from BECO (Booster Engine Cut-Off) through SECO (Second Stage Engine Cut-Off), Grissom agreed that the Titan was "a little bit noisy," noting that they picked up some aerodynamic noise just prior to breaking the sound barrier. Grissom noted the transition to supersonic by the decreasing noise and by a little flap on the antenna cover vibrating when he looked out of his window. In fact, he was quite concerned at one point that the flap would break off and come right through the window. Fortunately, everything quietened down after going sonic and the flap remained in place. At BECO, both astronauts reported seeing a flame which came across their windows and debris drifting around, "like fire or something," Grissom recalled. "The mess scattered around anyway. But there was no doubt in your mind that you had started accelerating again." The transition was not as sharp as experienced during training, but was much smoother, steering the vehicle down below the horizon and then back up again. First-time flyer John Young was enjoying the view and admitted "I couldn't keep my eyes off the window." At the end of the first stage flight, Young noted a high-frequency vibration on the back of his headrest, but due to the acceleration forces the pilot could not raise his head to dampen out the effect.

Both pilots thought Max Q was actually very quiet, as Young observed: "I didn't notice any bucking, [or] adverse needle movement or anything. At BECO, the fire came around there [the windows] and surprised me. I don't know what happened. Then the [second stage] engines lit off. …Fire in the Hole. You might have expected it from looking at the [Gemini 2 movies], seeing these things at BECO, but I had never thought about it. This is smooth acceleration. It's really low acceleration. But that boy [the Titan] pitched over and she was really picking up speed towards the end. Oh boy, that's really something. I couldn't keep from looking out the windows, so I kind of neglected my attitude [readings]."

Young then commented on the computer error FDI display, which indicated a 2- to 3-degree pitch down during the first stage boost. He thought it was a very smooth, steady steering period all the way through the first stage and was not really concerned, otherwise, he admitted, he would have told someone about it. Then, just as he was about to inform the ground about the pitch error, Cooper came on the radio and said the booster was indeed going high, which was the first indication Young had had. Cooper told the astronauts that it was nominal and there was nothing to worry about, so Young chose not to comment. Grissom noted that if Cooper had not informed them of the deviation, they would have been concerned.

When asked about jettisoning the scanner fairing after orbital insertion, Grissom commented "You could hear those things. I saw it pop off. The antenna fairing goes at the same time and it really makes a noise when it leaves, [and it leaves] junk all over the place. There are springs and pieces of metal flying every place. You could see some springs out in front of us for a good bit … there is no doubt in your mind that both of them [the fairings] are gone. The only thing that concerned me was some of that debris." Grissom said he was not worried about collision with the debris, but was concerned that some of the bits might get back into the scanners. He added "If one of those springs or pieces of debris got into a scanner head, you lose a scanner. I think it's a good idea to have the covers on."

Young raised a concern about moving his hands towards the SEP switches under *g* loads, noting "If you ever hit the wrong one it would be a natural disaster." Grissom casually pointed out that that was why they were locked, at which point Young said that he had noted that fact.

At SECO, Grissom forgot what time the burn had started, "so I just burned until I knew I had burned long enough," noting at the end that "the nose of the spacecraft was right on the horizon," precisely where it should have been.

Neither man could hear the firing of the aft OAMS thrusters during the separation of the Gemini from the spent Titan, even though Young was carefully listening out for them before he hit the switch. However, both men clearly heard the pyrotechnics fire to separate the spacecraft physically from the booster. "That's very clear," recalled Grissom, while Young described the event as sounding "like a 105-mm howitzer back there." Grissom continued: "So you know when you have separated. The only thing that concerned me was that I wasn't sure if we were thrusting." Then, just as in training, the spacecraft pitched down, forcing Grissom to use the pitch up control. This told him that the CG (center of gravity) was in the right spot. He controlled the roll rate, which he thought was high, but he soon damped it out and it stopped.

"When we separated," recalled Young, "all this stuff comes flying up over the windscreen. I never saw anything like it." Grissom likened the debris to shrapnel, but it disappeared very fast, moving out beyond them.

Both astronauts noted that the ride was smooth, without major vibrations or high noise levels. Then, at SECO, Young punched off the separation switch and, as Grissom recalled, "We got a good strong boot in the tail. There's is no doubt about it. Noisy, and a fair amount of debris flying around the spacecraft." In fact, there was so much debris flying around outside, it drew Young's attention.

In the post-fight news conference, held appropriately enough in the Gemini Room at the Carriage House Motel at Cocoa Beach, Florida two days after their flight, Young expanded upon his first views out the window of the Earth spreading out in front of him: “The view out of the window was unbelievable. You can’t take your eyes away from that window in the first few seconds of weightless flying. It’s incredible. There aren’t words in the English language to describe the beauty I felt [during] the last part of powered flight. I was supposed to monitor the Inertial Guidance System performance but … it’s just a tremendous effort to get your head back in the cockpit and look at those instruments. I think it’s the sort of thing that one is really fortunate to be able to get to do. I was impressed.” [7]

As impressed and distracted as Young may have been on his first spaceflight, there would be no time on this short mission to admire the view out the window for long, as the flight plan was pretty full and they would be challenged as they progressed through it. Almost immediately, Grissom found an unexpected left drift in the spacecraft which was puzzling. That would not be all in this demanding test flight. The crew would experience difficulties in keeping the temperature down, as well as in steadying the ‘8-ball’ flight director indicator and the horizon sensor, all while they were trying to evaluate crew systems and the habitability of the crew compartment. But this was a test flight and uncovering such issues was the point of flying just three orbits prior to embarking on much longer missions.

Then there were issues in defining the control of Gemini prior to the move to the new Mission Control Center on the next flight. The Titan launch vehicle also flew “too hot,” with more power than expected, while the re-entry proved “too mild” and affected the targeted landing. But there were lighter moments too, making Gemini 3 a memorable mission in ways neither the crew or NASA had envisaged.

Molly Brown was just the third Gemini mission and the only manned test flight of the program. With so much to do on this mission and with great plans in place for the nine to follow, this flight and the astronauts were expected to deliver results straight away. It was now time to get down to work, to achieve the stated primary objective for this mission of being able to maneuver in space, to deliver upon the promise of Gemini laid out just four years earlier and to build upon the two unmanned flights which had preceded this one.

References

1. Unofficial transcript of Gemini-Titan 3 mission, March 3, 1965, typed transcript of Paul Haney PAO commentary, copy on file AIS archives.
2. **Gemini,** Virgil ‘Gus’ Grissom, Macmillan, 1968, pp. 106-107.
3. *Gemini’s Journey*, Gus Grissom and John Young, Life Magazine April 2, 1965, p. 41.
4. **Forever Young,** John W. Young with James R. Hansen, University Press of Florida, 2012, p. 79.
5. *GT-3 Mission Report, Gemini 3 Supplementary Report 5, Air to Ground Voice Transcription*, MSC-G-R-65-2, June 23, 1965.
6. GT-*3 Flight Crew Technical Debriefing*, June 3, 1965. NASA Program Gemini Working Paper No 5025, Flight Crew Support Division.
7. *Astronauts describe flight at GT-3 press conference*, MSC Roundup, Volume 4 Number 12, April 2, 1965, p. 3.

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Mercury Mark II

"If there had been no Mercury program,
there would be no Gemini program;
if there had been no Gemini program,
there could be no Apollo program."
Virgil I. 'Gus' Grissom, *Gemini*.

For a long time, Gemini was a program overshadowed by the achievements of Apollo (1960-1975) and the initial American manned space program, Project Mercury (1959-1963). Now, however, it is seeing a resurgence of interest in its operations, half a century after the missions were flown. One reason for its relative anonymity is that Gemini was an intense but short-lived program, created in the early 1960s and matured over just three years. It was operational for just over 30 months and, despite grand plans, was all over by the end of 1966. Nevertheless, NASA's second manned space program was an indispensable lynch-pin between America's pioneering days with Project Mercury and the efforts to place the first humans on the Moon during Apollo. It also provided the groundwork for more extensive manned spaceflight operations, by developing key procedures that had application far beyond the Moon program of the 1960s. Gemini richly deserves recognition for its contributions both to the American program and to the global development of human spaceflight.

Gemini was created to serve a purpose and, despite a somewhat shaky start, achieved almost all that was expected of it. Those who worked on the program retained an affection for it that lasted far longer than the program itself. As Gus Grissom, who had helped to nurture the spacecraft to operational status, wrote shortly before he tragically lost his life, without Gemini, born of Mercury, there would have been no Apollo; at least, not as history records and certainly not as smoothly as the six missions demonstrated between October 1968 and November 1969, as they reached for the Moon during a spectacular year of achievement.

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_1

Playing catch-up

The Gemini program was created to meet an immediate need in the American space program: to gain experience in regular spaceflight operations. Project Mercury had proved that man could be launched into space aboard a one-shot space 'capsule', could perform some basic, useful work there and could survive the fiery re-entry to return to Earth, or more accurately water, with a splashdown in the planet's large oceans.[1] By the time the Gemini program was formally initiated, the United States had already been set the national goal of "landing a man on the Moon and returning him safely to the Earth" by the end of the decade. The historic speech by U.S. President John F. Kennedy on May 25, 1961, was made partly in response to the recent – and to a degree embarrassing – one-orbit flight of Soviet cosmonaut Yuri A. Gagarin aboard the spacecraft Vostok, as well as the disastrous CIA-led invasion at the Bay of Pigs against the communist-led island of Cuba.

In order to achieve Kennedy's goal, Gemini would first have to prove that longer spaceflights were possible, that rendezvous and docking could be achieved and that spacewalking, given adequate preparation and equipment, could be mastered. Since the American program was open to the world, Gemini would offer this evidence to other nations wishing to address these issues.

However, that was in the future. Back in the early 1960s, America was severely lacking in space leadership; so much so that the Soviets would grab most of the world's headlines in the first eight years of the space age: (1957) the first satellite and the first living creature (the dog, Laika) in orbit; (1959) the first lunar probe (Luna), the first object to reach another celestial body (the Moon with Luna 2) and the first spacecraft to pass behind the Moon and take images (Luna 3); (1961) the first man in space (Yuri Gagarin) and the first 24-hour manned spaceflight (Gherman S. Titov); (1962) the first dual flight (Vostok 3 and Vostok 4); (1963) the first long-duration flight (five days, Vostok 5) and the first woman in space (Valentina V. Tereshkova, Vostok 6); (1964) the first space 'crew' (three cosmonauts aboard Voskhod 1); (1965) the first spacewalk (Alexei A. Leonov on Voskhod 2).

It was not until the program of ten manned Gemini missions, launched on average at three-month intervals between March 1965 and November 1966, that America finally began to overhaul the Soviet lead in the so-called space race. It was Gemini that allowed the Americans to develop the procedures needed not only to reach the Moon, but to establish a routine access to space, supported by pinpoint recovery and an extensive ground infrastructure. Five decades after the Gemini program concluded, these systems, together with the previously mentioned rendezvous and docking, spacewalking and long-duration spaceflight techniques, are precisely the same ones employed to keep the International Space Station flying.

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[1] The early astronauts always preferred the term space 'craft' rather than space 'capsule'. As most of them were seasoned pilots, they reasoned you could operate or fly a 'craft', but would usually take a 'capsule' for medical reasons.

THE ORIGINS OF A PROGRAM

Five years before a Gemini spacecraft left the launch pad, the possibility of such a program was explored during a meeting of a NASA committee chaired by Harry J. Goett of the Ames Research Center. During the two-day meeting, held over May 25 and 26, 1959, the committee evaluated the idea of enlarging the design of the one-man Mercury spacecraft by fifty percent to accommodate two astronauts for two to three days. The idea of an upgraded Mercury spacecraft was appealing not only to NASA but also to prime contractor McDonnell, as Mercury was severely limited for anything beyond supporting the solo pilot for up to one day, with little opportunity to perform scientific experiments and no capability for either maneuvering or leaving the spacecraft in orbit.[2]

In August 1959, while McDonnell looked into what would be required to modify the basic Mercury design, elements of the Space Task Group (STG) began to look more seriously at an even more advanced Mercury-type spacecraft. On August 12, the STG's New Projects Panel requested the group's Flight Systems Division to begin studies of a second-generation manned spacecraft that had significant improvements over the original Mercury. By April 1961, a number of new systems had been proposed for this advanced Mercury spacecraft, most notable of which were the inclusion of a re-entry control navigation system to improve the accuracy of landing and the installation of controls to allow the crew to perform a rendezvous in orbit with a second vehicle.

Enter Apollo… and Vostok

The idea, indeed the desire, to develop a large spacecraft to support an advanced space program that would include manned flights to the Moon, had its initial support in the late 1950s, both in the military and at NASA. During the same STG meeting in August 1959, discussions into the idea of improving the Mercury spacecraft ran parallel to the New Project Panel's focus upon the future manned program and a proposed second-generation, three-man capsule. This would include the "potential for near-lunar return velocities," in other words flights around the lunar far side – more commonly known as circumlunar trajectories – and would use the new large Saturn launch vehicle. On July 25, 1960, as these studies continued, the name 'Apollo' was chosen for the advanced three-man spacecraft, with plans to utilize them to support manned lunar landings and to service a permanent space station.

In February 1961, McDonnell held discussions with NASA about how they envisaged improving the design of Mercury to include a second astronaut. In fact, these studies pointed to two different versions of the advanced Mercury spacecraft. Firstly, minimal changes would be made to the basic Mercury spacecraft, allowing one astronaut to fly for 18 orbits (27 hours, or 1 day). More significant changes would be required to improve the design sufficiently to support two men on more advanced missions and this clearly pointed towards a brand new spacecraft. For a while, this improved concept became known as Mercury Mark II, instead of Advanced Mercury, based upon the suggestion of STG

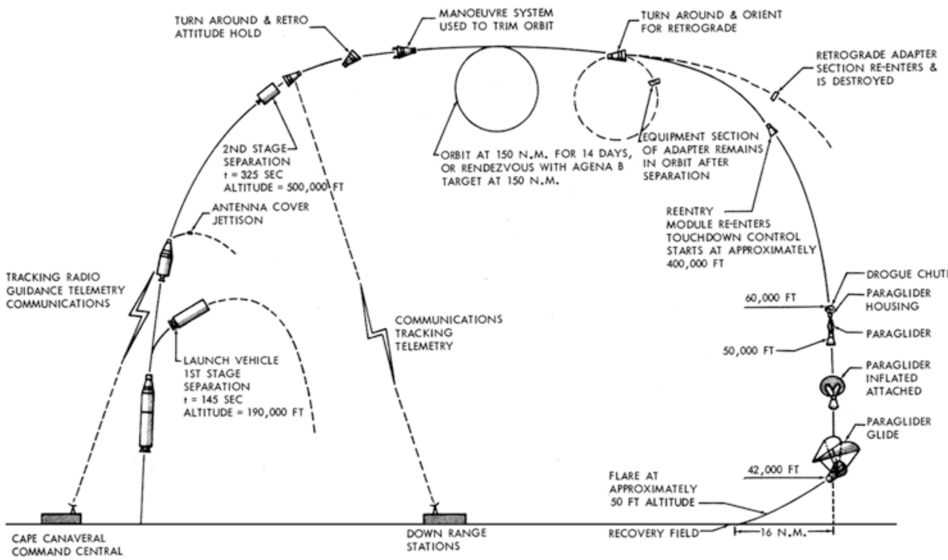
[2] McDonnell Aircraft (founded in 1939), the primary contractor of the Mercury and Gemini spacecraft, merged with the Douglas Aircraft Company in 1967 to form McDonnell-Douglas, which was subsequently acquired by Boeing in 1997.

contracting officer Glenn F. Baily and John Y. Brown of McDonnell Aircraft Corporation. On April 14, 1961, just two days after Yuri Gagarin became the first man to fly in space, NASA issued a study contract to McDonnell for improving the Mercury spacecraft. Plans were being put in place for far more advanced missions even before the basic one-man design had flown with an astronaut on board.

In the aftermath of the historic single-orbit flight of Yuri Gagarin in Vostok, the global headlines hailing the achievement echoed through the hallowed halls of NASA and the White House. Over the next few weeks, the best course of action to respond to the clear lead the Soviet Union held over America in space was debated. Their first response came on May 5, 1961, in the 15-minute suborbital flight of Alan B. Shepard aboard Mercury 3/*Freedom 7*. Although Shepard had not attained orbit, at least America could claim they had their first ‘spaceman’. It was a start, albeit a small one. While NASA and the White House debated a more appropriate, bold response to the Soviet successes and the perceived strategic threat, representatives from the Martin Company, which had built the Titan missile system for the USAF, briefed NASA officials on May 8 (just three days after Shepard’s flight) about the potential of using the Titan as a launch vehicle for future manned spacecraft. Two months later, as Virgil ‘Gus’ Grissom flew the second American suborbital mission aboard Mercury 4/*Liberty Bell 7*, NASA received a proposal from Martin that outlined utilizing the Titan to boost the advanced Mercury II spacecraft into orbit. Titan would be a much more powerful vehicle than either the Redstone that had been used for the suborbital Mercury missions or the Atlas planned for the orbital flights.

During May, another advanced idea also gained support as a potential objective for Mercury Mark II. On May 17, 1961, a statement of work was issued to Goodyear Aircraft Corporation, North American Aviation Inc. and Ryan Aeronautical Company to develop the concept of a paraglider landing system (known as the Rogallo Wing) to control a manned spacecraft to a descent on land, rather than a costly ocean splashdown. Barely a week later, on May 25, President Kennedy spoke before the U.S. Congress, calling for new, bold, long-range plans for the nation’s space program, including the landing of a man on the Moon by the end of the decade. Within NASA, it was clear that there would be much to do to achieve this target and with only 15 minutes on the U.S. manned spaceflight log book, an immediate need was identified to develop a series of flights which were not part of the Apollo program, but which could support the lunar effort by developing the procedures necessary for Apollo to be able to meet President Kennedy’s deadline.

One of the decisions to be made in order to send Apollo to the Moon was exactly how to achieve the flight profile. Three leading methods were evaluated. Direct Ascent (DA), where the whole vehicle would be sent straight to the lunar surface, would require a more massive vehicle than currently under development, whereas Earth Orbital Rendezvous (EOR) would see separate elements of the “moon ship” assembled in Earth orbit before making the lunar voyage. Then there was Lunar Orbital Rendezvous (LOR), where only part of the spacecraft would be used for the landing while the larger mother ship remained in lunar orbit. This would obviate taking all the return fuel, supplies, heat shields and engines to the surface, saving weight on the lander and easing the performance requirements on the lander’s ascent engine for leaving the surface. Both EOR and LOR would involve extensive capability for proximity operations, which would require close-formation flying of more than one spacecraft, as well as rendezvous and docking to bring two separate spacecraft together and join them up mechanically and safely to allow the transfer of astronauts and equipment between them. The LOR method was eventually chosen for Apollo in 1962, with the Command and Service Module (CSM) mother ship accompanied by the Lunar Excursion Module (LEM; the word 'Excursion' was later dropped and the module was simply known as the LM, though it was still pronounced as "LEM"). The flight profile debate had identified the need for Mercury Mark II to master the techniques of rendezvous and docking in Earth orbit before trying it with Apollo either in Earth orbit or around the Moon.



Early diagram of the Gemini mission profile, including a 14-day mission duration, a docking with an unmanned Agena B target vehicle and the planned land-landing, subsequently revised to an ocean splashdown. EVA (spacewalking) was not indicated at this point.

By the end of 1961, the plans for Mercury Mark II were becoming clearer and a definitive program was emerging. On December 7, NASA Associate Administrator Robert C. Seamans approved the development plan for a two-man spacecraft launched by the USAF Titan II. It would be capable of much longer missions than its historic predecessor, possibly up to two weeks, which was thought to be the most suitable duration for sending a manned mission to the Moon, performing a landing and short stay and returning to Earth. A second air force launch vehicle, the Atlas which would also be used to launch the Mercury orbital missions, would carry an Agena B target vehicle (later changed to Agena D) into orbit to provide a suitable target for the Mercury Mark II manned spacecraft to perform rendezvous and docking exercises with in Earth orbit. Another stated objective for this program was the development of the land-landing capability.

The flights of the new program were expected to start in 1963, just after the operational end of Project Mercury. Commencing flight operations of a new spacecraft in less than two years would be an added challenge. On December 15, 1961, just a week after the program was approved, McDonnell received a letter contract from NASA for the development of twelve Mark II spacecraft. This was subsequently amended to include an additional craft for use in ground testing, with the final contract being signed on April 2, 1963. On the day after Christmas 1961 (December 26), NASA directed the Air Force Space Systems Division to instruct Titan prime contractor Martin and other launch vehicle contractors to commence modifying the Titan II for Mercury Mark II flights.[3] The final contract for 15 vehicles eventually arrived on January 19, 1962.

Project Gemini, the heavenly twins

With the program gathering pace, it was time to give it a more formal name. To focus attention on this, an ad-hoc naming committee was established to come up with a suitable designation, from suggestions made by staff at NASA Headquarters in Washington. Some of the names put forward for consideration had included *Diana, Valiant* and *Orpheus*, but it was the suggestion of *Gemini* by Alexi P. Nagy that won the competition's token award.

The official Gemini Program emblem featured the distinctive Roman II, for a number of symbolic connections. Gemini was the second U.S. manned spaceflight program after Mercury (itself named after the Roman messenger God). Just as the constellation Gemini has twin stars, there would be two astronauts on each flight. The main launch vehicle was the Titan II, the longest mission was planned for two weeks and there was an acknowledgment to its origin in Mercury Mark II.

It was a logical choice. In the field of astrology, Gemini is controlled by Mercury. Gemini was also Latin for *twins*, reflecting the two-man crew, although Nagy had not linked the name to astrology or astronomy. The twin stars of the constellation Gemini,

[3] In the United States, December 26 is known as 'The Day After Christmas' and is not always recognized as an official holiday.

Castor and Pollux, were patron gods of voyagers and for two-week missions, the astronauts would need all the help they could get. To trace its roots and links to Project Mercury, the original Mercury Mark II symbol was kept in the Gemini program emblem. It also neatly symbolized the two-man crew, the docking of two vehicles and the use of the Titan II launch vehicle. It seemed so simple and suitable, with the only stumbling block being how to pronounce the name – was it 'Gemin*ee*' or 'Gemin*eye*'? Many supported the former, while there remains today a strong preference for the latter. [1]

The name 'Gemini' was chosen as the official designation of the former Mercury Mark II program on January 3, 1962, thus becoming America's second-generation manned space program. The Gemini Program office was established by the middle of that month and by that point, the former Space Task Group at Langley Field, Virginia, had been renamed the Manned Spacecraft Center and was in the process of moving about 1200 miles (1930 km) to a new site, still under construction, 30 miles (48 km) south of downtown Houston, Texas. [2] The program would be managed from here, under the direction of the Office of Manned Space Flight at NASA Headquarters in Washington D.C.[4]

By the end of January, a total of eleven Agena B target vehicles and Atlas boosters had been procured through the USAF. Shortly afterwards, the Lockheed Missile and Space Company received a letter contract for modifications to eight of the Agenas. Initially, the Marshall Space Flight Center (MSFC) in Alabama was involved in procuring the Atlas-Agenas, but in January 1963 this was moved to MSC in Houston.

While the program itself was being defined, the design of the spacecraft continued to develop, until March 31, 1962, when the configuration was formally frozen. Five months later, the decision was taken to replace the Agena B target vehicle for the more advanced and versatile Agena D stage.

Gemini in context

While it is well known that the design of Gemini evolved from that of the one-man Mercury spacecraft and was built by the same contractor, McDonnell, Gemini was certainly more than just an upgraded Mercury. It eventually became a completely different vehicle, with far greater capability and objectives than could ever have been hoped for from America's pioneering spacecraft.[5] While the Mercury program was held in great affection for its role in sending Americans into space for the first time, Gemini would also become a favorite for those who designed, built and prepared them, as well as those who flew onboard.

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[4] The Manned Spacecraft Center at Clear Lake, near Houston, Texas, officially opened in June 1964, but staff from Langley had been transferred to Houston in late 1961, into temporary offices (two vacant former dress shops) in the Gulfgate Shopping Center. Over the next two and a half years, further staff were transferred to or employed at the MSC facility, as it expanded concurrently with the Gemini program's development towards its first flights.

[5] In October 1964, the Soviets had showcased their first manned Voskhod flight as a new type of spacecraft. Some years later, it was revealed that Voskhod was in fact merely a stripped-down Vostok with minimal improvements, to support a three-man crew or, as on the second flight, an EVA capability.

These early spacecraft, Mercury, Gemini and Apollo from America, or Vostok and Voskhod from the Soviet Union, were limited both in production and capability, but each played their role admirably in opening up the era of human spaceflight. There was, by design, a limitation both in what was expected and could be achieved, but also in the number of seats available to those chosen to fly the missions. In comparison to the 135 missions of the Space Shuttle and almost as many flights of the Russian Soyuz, those early manned missions were never to climb into the high teens. There were just eight missions for Vostok/Voskhod, a lowly six for Mercury, fifteen for Apollo – if the three Skylab and single ASTP missions are included – and the ten of Gemini. A total of 39 pioneering adventures contributed to the opening pages of human spaceflight history.

What made Gemini stand out were the objectives set for it, the manner in which these were attained and surpassed (almost exactly as suggested in the earliest proposals for the idea of creating the program) and the time it took to achieve them. While the first-era spacecraft such as Vostok and Mercury were created to place men (and in one case a woman) in space, survive the adventure and return safely to Earth, once that had been done much more was expected from each mission and their capacity was stretched to the limit. This was most clearly demonstrated in the short-lived Voskhod program, which was derived from stripping down Vostok and really pushed the limits of the spacecraft, the crew and their luck. The follow-on programs, Apollo and Soyuz, were in the minds of designers before Gemini became a reality. Both demonstrated maturity, flexibility in their capabilities and, in the case of Soyuz, longevity by necessity, with that spacecraft still flying 50 years after it first appeared and forming the blueprint for the Chinese Shenzhou spacecraft that has recently emerged on the human spaceflight scene.

But it was Gemini that pushed the boundaries of human spaceflight in the mid-1960s, bridging the gap between Earth orbit and the Moon, as well as between the pioneering programs of both the Mercury and Vostok/Voskhod series and Apollo and, to a degree, Soyuz. Though much was projected for Gemini which did not mature into actual spaceflights, it was meeting and mastering certain important techniques in human spaceflight that gave Gemini its place in the history books. Gemini offered the United States the most logical step forward from Mercury with a minimum of time and expense and then went on to achieve a number of significant milestones in human spaceflight history:

- Gemini provided the opportunity to subject a two-man crew and supporting equipment to extended-duration flight in Earth orbit (from a few hours up to two weeks), allowing research and experiences to be applied to later trips to the Moon, to stations in space and, whenever it occurs, to future excursions further into the Solar System.
- The missions finally proved the decades of theory behind rendezvous and docking of orbiting vehicles. They added to this by demonstrating early experiments in tethering spacecraft to create a small gravitational force by spinning the combination and, more importantly, the ability to maneuver the combined spacecraft using the propulsion system of the target spacecraft. This was an essential tool in developing extensive space operations involving more than one vehicle, which continues today

with regular missions to and from the International Space Station. The station itself was created utilizing the skills of rendezvous, docking and proximity operations that were pioneered on Gemini.

- In March 1965, the Soviets were the first to achieve the feat of having a space-suited crewmember leave their spacecraft in the vacuum of space to complete an Extra Vehicular Activity, or 'spacewalk'. They conducted further brief excursions from Soyuz in 1969 and Salyut 6 between 1977 and 1979, but did not truly begin to master the techniques of EVA from a station in space until the mid-1980s. During Gemini, astronauts also experimented with leaving the spacecraft in orbit and tried to determine their ability to perform various tasks, soon discovering how difficult such an exercise really is without adequate training, restraint and equipment. For Apollo, a different type of EVA was explored, on the surface of another celestial body. While this was just as challenging, the task was made easier and safer by the EVAs from Gemini, which had proven critical in recognizing the limitations of working in open space. All of these excursions, together with the few EVAs from Skylab (ironically through an old, recycled Gemini hatch in the Orbital Workshop), created a baseline from which the skills and hardware for regular (but never routine) space servicing, construction and repair could be developed. These became a leading highlight of Space Shuttle missions, in the repair and maintenance of the Hubble Space Telescope and in the creation of the International Space Station.
- Though the original plan was to recover Gemini on land, this was not achieved, for reasons explained below. However, the program did contribute to understanding and perfecting methods of re-entry and landing of a manned spacecraft at pre-selected landing areas, reducing the need for extensive search and rescue teams and shortening the time from completing the flight to recovering the crew and spacecraft safely. This still has application for each manned mission returning from space.
- Perhaps less prominent in the headlines from Gemini than spacewalking, docking or pinpoint landings was the wealth of information gathered from keeping a crew in space and from monitoring the early effects of weightlessness and the psychological reactions from those activities. There was also the host of medical data gathered which would be applied not only to Apollo but also to the Skylab, Shuttle and space station programs which followed. Gemini provided a greater understanding of the effects of spaceflight on the human body in the first hours, days and weeks. This information was gathered for the first spaceflights of these well-trained professional astronauts and, in some cases, on their return for a second mission, providing comparison data on the same person.
- Gemini also provided the astronauts with the most useful training tool available to a space explorer: actually flying in space. Despite hundreds of hours of training and simulations on Earth, there is nowhere that can provide spaceflight experiences better than flying a mission into space and going through the particular events and phenomena of such a trip. Russian cosmonauts have long put forward the idea that you cannot consider yourself a true explorer of space until you have flown at least one orbit. Training, simulators, even today's virtual reality and the future prospect

of tantalizing short 'tourist' trips to the fringes of space are not the same as orbital flight. Truly learning to live and work in microgravity for extended periods was first addressed during the ten Gemini manned missions of 1965 and 1966, gathering hands-on experience of rendezvous and docking, EVA, long-duration flight and attaining mission objectives while maintaining crew compatibility. Again, all these lessons contribute to the continuing success of the ISS.
- With its program keeping astronauts in space for up to two weeks, Gemini offered the opportunity to conduct useful scientific and technological experiments secondary to the main flight objectives. Not until Skylab and Salyut would crews be able to devote the time and energy to scientific observations and investigations in prolonged microgravity that Gemini afforded. Supplemented by learning to live and work in the one-sixth gravity environment of the Moon, Gemini once again contributed to a database of flight crew operations that led to creating and understanding flight crew activities planning on the Shuttle and ISS.
- Gemini's contributions to a greater understanding of how to send humans into space and support them while there did not only apply on orbit. There were lessons learned on the ground as well. The nature of the program required a greater support infrastructure to develop the missions and hardware, to prepare and launch each flight and then recycle the same pad in time for the next mission, to control the missions, to track and communicate with them and to recover them at the end of the flight. The restricted time between missions stretched the capabilities of teams on the ground to analyze data from the last mission in time to prepare and launch the next one. The character of Mission Control 'Houston', nurtured from Mercury Control, was created during Gemini, developing into the ethos of what became Apollo mission control and evolving into the current international mission control system which supports the 24/7, 365-days-a-year operations on ISS.
- Gemini also developed the support of industry, academia, the military and politicians and the enthusiasm of the public, all fired by 'real' stories of the astronauts in the media, extending the era of the "*Right Stuff*" of both the test pilots at Edwards Air Force Base and the Mercury astronauts to those who flew on Gemini. They, too, became household names and recognized celebrities (a status that was not necessarily desired) in the 1960s.

Gemini was created to demonstrate that a crew could live in the cramped confines of the spacecraft for up to two weeks; that they could fly the spacecraft to find and latch up to a second spacecraft and use that vehicle to boost the combination to higher orbits; and that perhaps one of the crew could step outside for a while to evaluate the concept of working outside a space vehicle, a new phenomenon called Extra Vehicular Activity (EVA), or more commonly 'spacewalking'. Gemini could support all of this and, given the opportunity, probably a lot more. It was also a pivotal program in which the skills and techniques for truly understanding long term regular space operations were learned. But was the full potential of the vehicle realized? This could only effectively be evaluated at the end of the program and will be explored by the author in the Gemini 12 title.

Gemini cutaway revealing the Rendezvous and Recovery section at the front, small end of the spacecraft, the two-astronaut crew compartment, the Retrograde section and the Adapter Module at the rear.

THE MAIN HARDWARE

Overviews of the development of the Gemini program, its hardware, management and ground infrastructure, were presented in the 2001 volume *Gemini: Steps to the Moon* by the author. Additional information can be found in the titles listed in the bibliography at the back of this book. For the purposes of quick reference and revision, a brief description of the basic Gemini spacecraft is presented here, together with that of its main launch vehicle and a guide to the basic mission profile. Details of the development of EVA suits and equipment, techniques of rendezvous and docking and the various experiments will be covered as this series progresses.

The spacecraft

The Gemini spacecraft was in fact two major units linked together for most of the mission. At the rear was the Adapter Module (usually white in color), which itself comprised two sections: the inner Retrograde Section and the outer Equipment Section. The Re-entry

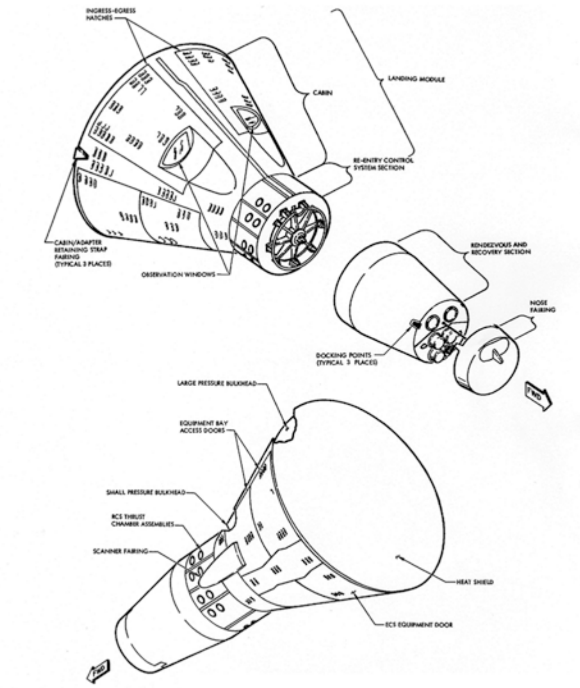
Module (usually gray), was located forward of the Adapter Module and consisted of a Rendezvous and Recovery Section at the extreme forward point (nose) of the spacecraft, the Re-entry Control Section next and then the Conical (crew compartment) Section, at the base of which was the heat-shield. A nose-fairing was attached to the forward end of the Rendezvous and Recovery Section to protect that part of the spacecraft for the ascent through the atmosphere during launch. The fairing was ejected just prior to entering orbit.

The spacecraft was fabricated using heat-resistant titanium and magnesium, with added externally-mounted René 41 shingles on the Conical Section, including the two outward-opening hatches. These hatches were also fitted with a three-pane design observation window. Beryllium was utilized for additional protection on the nose of the spacecraft. Protection during re-entry was provided by a silicone elastomer in the form of an ablative heat shield at the large, blunt end of the Re-entry Module.

The commander of the vehicle (Command Pilot) occupied the left crew station, while the co-pilot (Pilot) sat in the right-hand seat. Attitude control of the spacecraft came from a system of eight 11-newton thrusters, with translation along any axis by means of six 445-newton thrusters and a pair of 378-newton thrusters. Recovery from orbit was initiated by firing four retrograde rockets located in the Retrograde Section of the vehicle. Originally, Gemini was to have only chemical silver-oxide batteries for power, but the batteries could not support the planned longer missions, so fuel cells were developed to maintain electrical power on flights of up to two weeks. [3]

The forward Re-entry Module appeared similar to the bell-shaped Mercury but of course was considerably larger. Mercury measured 9 ft. (2.7 m) high and 6 ft. (1.8 m) in diameter at the heat shield end, just large enough for one astronaut. To accommodate its crew of two, Gemini now had an 11-ft-high (3.3 m) Re-entry Module and a heat shield base of 7.5 ft. (2.3 m). With the Adapter Module attached, Gemini looked much larger than its older brother. Images of the completed spacecraft on a transport dolly revealed a 19-ft-high (5.8 m) spacecraft of about 7,000 lbs. (3,175 kg) in mass, compared to the smaller, 4,000 lbs. (1,814 kg) Mercury. Both spacecraft would be considered small by today's standards and this was partly governed by the diameters of the available launch vehicles, but Gemini still offered fifty percent more volume than Mercury, though of course there would be two astronauts inside, not one. The old saying that a Mercury astronaut never really "rode" in the capsule but merely "put it on" to fly the mission helps to visualize the lack of room in that spacecraft. For Gemini, perhaps the best description was the comparison of a long-duration mission to enduring the challenge of a two-week camping trip – spent entirely in the front seats of a Volkswagen Beetle.

Apart from the difference in size, there were many other things that separated the two pioneering American spacecraft and it soon became clear that while they may have been born of the same mold, they were not identical twins. Perhaps the prime difference was in the control of the two vehicles. As the inaugural American manned orbital spacecraft, the Mercury design was a ballistic shape and not the winged lifting-body configuration preferred by test pilots. Mercury incorporated completely automatic control capability from the ground but also, at the insistence of the astronauts, the capability of switching control over to the pilot. The astronauts could control the attitude of the spacecraft but could not maneuver it. Despite such limits, the Mercury program demonstrated on several occasions



Detail of the Re-entry Module structure.

that the astronauts could handle systems difficulties. As a result, the astronauts were given the ability to control and monitor the Gemini spacecraft themselves and the design of the crew compartment allowed either astronaut to 'fly' the vehicle should the occasion have arisen. Of course, maneuverability was planned for Gemini from the beginning, simply because of the rendezvous and docking objectives and the requirement to control the re-entry and landing phase of the mission.

Even the basic designs of the two spacecraft were approached in significantly different ways. Fundamentally, Mercury was a research and development spacecraft, a pioneer in the genre for the Americans, at least in ballistic capsule design. As everything in Mercury would be placed in orbit with the astronauts, its systems and subsystems were located inside the pilot's cabin and stacked on top of each other, similar to the layers of a cake. The drawback to this was that if a system failed during preparation for launch, it could require the removal of other units and possible disturbance of hitherto correctly operating systems to reach the problem area. This was both risky and time consuming. As Mercury was so small, it also meant that apart from the retro-rocket package that was jettisoned prior to entry, everything that was taken into orbit was also brought back down; additional mass that the recovery parachute system had to be able to cope with as the spacecraft headed for splashdown.

For Gemini, the systems were modularized, with as many elements of each system as possible contained in compact packages. These were then installed so that they could be replaced more easily and without disrupting other systems. In addition, there were flight-ready spares available that could be installed promptly if required during the preparations for launch. This was quicker and much simpler. Of course, Gemini, like Mercury and Apollo, was designed as a 'one-shot' spacecraft, but these developments and learning curves, together with results from each mission, significantly enhanced NASA's understanding of spacecraft design, economics and operations, leading in turn towards the development and introduction of Orbital Replacement Units (ORUs) in the space program. These ORUs later featured on both manned and unmanned spacecraft and were designed to prolong and upgrade their orbital service life, as witnessed in the highly successful repair and servicing of the Hubble Space Telescope and the continued maintenance of the International Space Station, for example.

Gemini's Re-entry Module included packages of equipment which were located on the outer walls, designed for rapid replacement without the need to enter the crew compartment. Therefore, only the visual instrumentation, flight controls, communications and life support equipment were included inside the crew compartment, together with food, water, waste handling equipment, survival gear and breathing apparatus. The addition of the Adapter Module Equipment Section also allowed the fuel supplies and associated equipment to be located outside the crew compartment. This section would not return at the end of the mission, which meant that the equipment it contained did not have to be included in calculations of the mass for re-entry and landing, thus lightening the load for the recovery parachute system.

Another innovation for Gemini was in the area of crew safety. Project Mercury had included an escape tower and while a similar system was considered for Gemini early in its development, it was instead decided to provide ejection seats for the two pilots in the crew compartment, both for escape during a troubled ascent and for low-altitude ejection during a problematic landing.[6] The decision to use ejection seats rather than an escape rocket was based on the type of fuel used on the Titan launch vehicle. For Mercury, both the Redstone and the Atlas used explosive fuels, hence the need for a rapid evacuation with the escape rocket pulling the capsule away from a probable fireball. For Gemini, the modified Titan II ballistic missile used fuel which burned on contact with the oxidizer rather than exploding. The use of ejection seats would also give the crew the possibility of escaping their craft at low altitudes if problems occurred during parachute recovery.

[6] Previously in manned spacecraft design, ejection seats had only been available on the six manned Vostok missions, both for crew escape and for a separate parachute descent at the end of the mission as the spacecraft's parachute could not handle the additional weight of the cosmonaut. For the Apollo/Saturn era, launch escape rockets were provided, but for the first four orbital test flights of the Space Shuttle *Columbia*, ejection seats were installed for the two-man crews. These were deactivated for the fifth flight (STS-5) and removed prior to its sixth mission on STS-9. For the remaining flights of *Columbia* and all the flights of *Challenger*, *Discovery*, *Atlantis* and *Endeavour*, there were no significant crew escape systems fitted, though there were a number of abort flight profiles available and, from STS-26, a slide-wire escape pole system incorporated on the middeck. This was never used operationally.

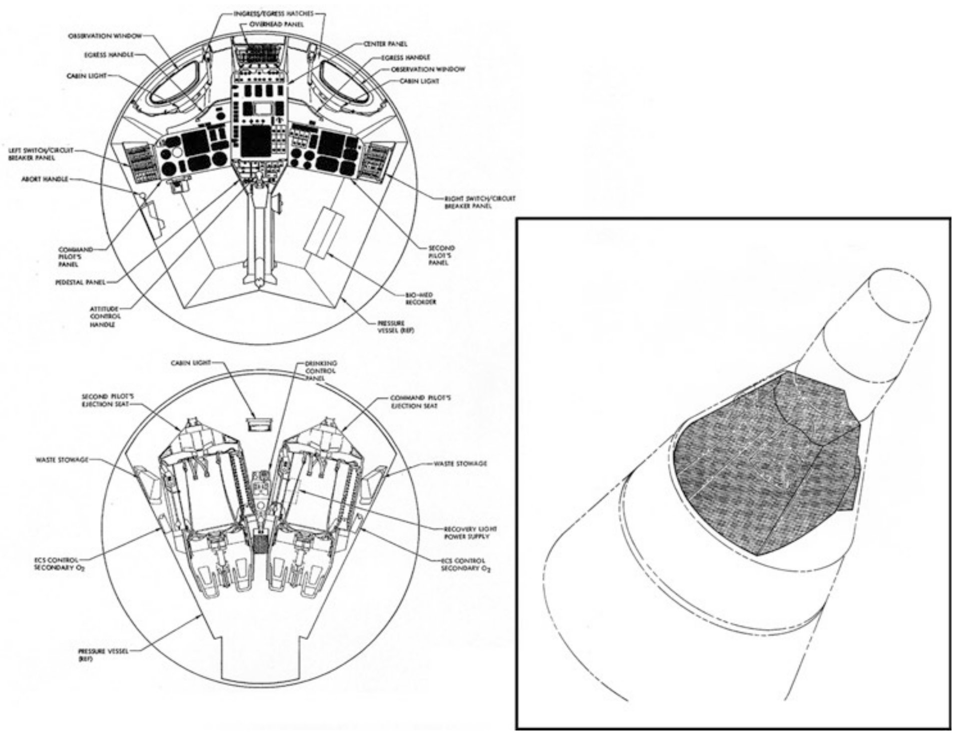
Numerous tests were conducted to qualify the escape system for Gemini. These tests were designed to evaluate center-of-gravity and thrust-vector relationships in the design and ejection process. Using both men and anthropomorphic dummies, these tests qualified the system to an altitude of 45,000 ft. (13,716 m), at velocities in excess of 1,600 ft./sec (487.68 m/sec) and at a dynamic pressure of over 750 psf. (3,661.8 kg/m^2). The program included testing in the wind tunnel, static tests to evaluate the seat-occupant separation and, starting in April 1963, rocket-catapult tests beyond those normally used in ejection-seat rocket development because of the altitude and velocities at which the system was expected to operate. These were followed by a series of harness tests using a torso dummy and comfort tests using live jump subjects. A series of nineteen dummy parachute drops from altitudes of between 1,000 and 1,200 feet (304.8 m – 365.76 m) were completed during June and July of 1962 and these were followed by a second series of fourteen drops conducted between March and May 1963, this time from helicopters and various aircraft at altitudes varying between 1,000 and 12,300 ft. (304.8 m – 3,749 m). Further tests were completed over the next two years, involving a dummy or live subject conducting parachute drops at various altitudes and velocities. The program of twelve simulated pad-ejection tests was conducted between July 1962 and July 1963, followed by four qualification sled tests during 1964. Finally, there were three simulated off-the-pad ejection tests on January 16, February 12 and the last on March 6, 1965, just seventeen days before Gus Grissom and John Young were strapped into Gemini 3 for the first manned launch. [4]

The primary equipment located in the different sections of Gemini, going from the front of the spacecraft aft, was:

Rendezvous and Recovery Section: The radar equipment used on rendezvous missions and the drogue and main parachute recovery system.

Re-entry Control Section: The fuel and oxidizer tanks and their associated valves and tubing assembles, as well as the thrust chamber assemblies for the Re-entry Control System (RCS).

Conical Section: According to the Gemini Technical Summary, "The focal point in the operation of a spacecraft is the crew station. The primary goal of the design phase was to produce a simple, reliable and effective display and control system which would complement an intelligent, well-trained astronaut in the performance of the mission." [5] To attain this, simple and off-the-shelf components were used, such as display meters instead of cathode ray tubes. Ground-based and automated onboard systems in important control functions were eliminated, relying instead solely on astronaut judgment. The astronauts could select various operating modes by switching both controls and displays. For critical sequences, such as the all-important retro-fire at the end of the mission, dual mechanical and electrical interlocks were installed to prevent inadvertent actions or malfunctions. The layout of the two crew locations saw the piloting functions placed at the left-hand station, while the engineer and navigation functions were located on the right. Common functions were located in the center. This was the only element to contain an internal pressurized section.



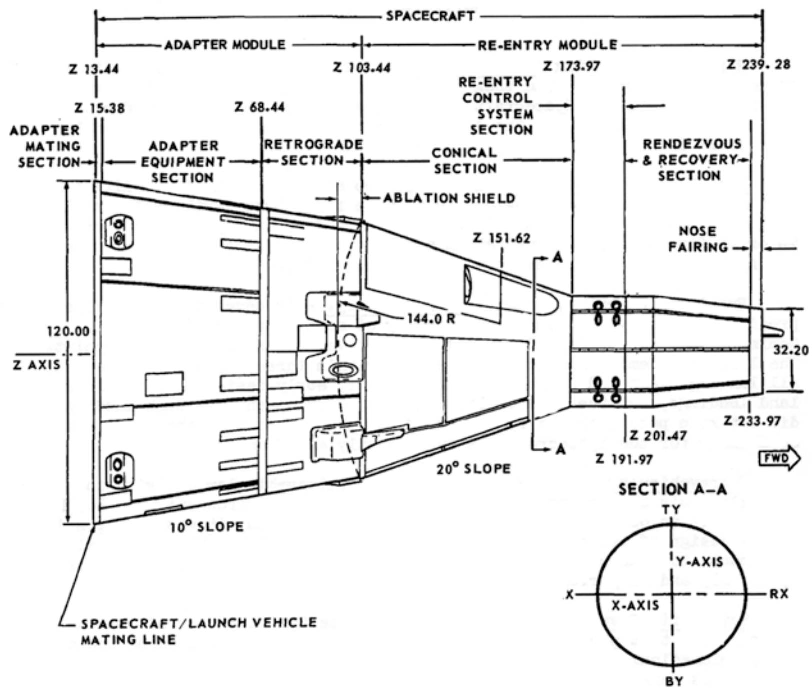
A typical illustration of the Gemini crew compartment equipment. [Inset] The extent of the cabin pressure vessel within the Gemini spacecraft.

The instrumentation packages and electronics gear were housed between the pressurized section and the outer skin of the re-entry compartment. There were two crew hatches in the spacecraft, which were symmetrically located on the ‘top-side’ of the vehicle. Both were hinged to open outwards and could be operated manually by means of a handle and mechanical latching mechanism. On launch day, for entry into the spacecraft from the White Room on top of the gantry with the Gemini positioned vertically atop the launch vehicle, crew access was by sliding into each seat, which were canted 90 degrees from the horizontal. In the event of crew ejection, the hatch would have opened automatically, allowing the ejection seat to travel on its rails and propel the pilot away from pending disaster for individual parachute recovery. In one such test of the ejection system, on January 16, 1965, the O-rings in the right-hand (Pilot) hatch actuator failed to open before the empty test seat plowed straight though the hatch. Witnessing the event was Gemini 3 pilot John W. Young, who was just two months away from sitting the same seat position aboard his spacecraft. Typically, he quipped that had this happened on a real flight, the unfortunate astronaut would have suffered “a hell of a headache, but a short one.”

The Command Pilot in Gemini's left-hand position normally handled the controls of the spacecraft to conduct rendezvous and docking. The Pilot in the right-hand seat would be the one who performed spacewalks through that hatch, during Gemini 4 and the later flights in the program. Both hatches featured a small, forward-facing window for observation, consisting of an inner, middle and outer pane. They were subject to debris from the rocket exhaust and fogging during the longer missions.

Retrograde Section: Joining the Conical Section and the Adapter Module, this section housed the four retrograde rockets and the six Orbital Attitude and Maneuvering System (OAMS) thrust chamber assemblies.

Adapter Module Equipment Section: The rear-most edge of this section was mated to the Titan launch vehicle upper second stage, while its upper edge was mated to the Retrograde Section. The Adapter Equipment Section was also the location for the primary oxygen supply for the crew, storage batteries and/or fuel cells (on later missions), coolant, electrical and electronic components and the ten OAMS thrust chamber assemblies around the large diameter at the base of the section.



The details of the Gemini spacecraft main components plus the axis of the spacecraft used during location explanations.

For reference

To make the identification of particular area of the spacecraft more straightforward, Gemini designers utilized the three-axis reference planes. One ran longitudinally from the adapter to the nose (Z-axis), the second vertically through the center (Y-axis) and the third horizontally (X-axis). Looking forward from the end of the adapter, the spacecraft was divided into four quadrants and thus the four cardinal, main-points-on-a-compass locations (see section A-A in the diagram on page **17**): TY (top Y) and BY (bottom Y) for the Y axis, and RX (right X) and LX (left X) for the X axis. Any particular location on the circle was measured in degrees from any one of these points. The Z-axis locations (or stations) were identified longitudinally from the rear of the spacecraft to the nose. An example is the separation point between the Re-entry Module and the Adapter Section, which was station Z 102.00 (inches). The nose of the spacecraft was identified as station Z 239.53 (inches), which was Z 239.28 plus 0.25 (inches) of ablative material.

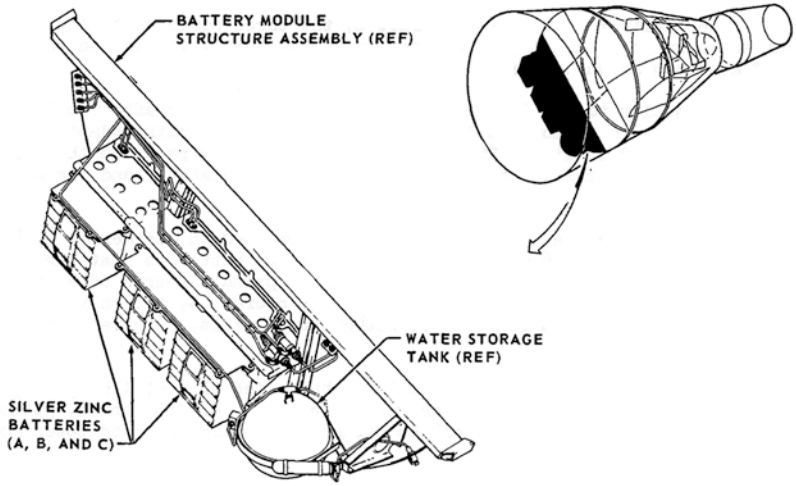
Batteries included

Though fuel-cell technology was provided for seven of the Gemini missions (Gemini 5, 7, and 8 through 12), conventional batteries were carried on all flights to support electrically-powered equipment and were the sole source of electrical power for the unmanned test flights of Gemini 1 and 2 and the manned flights of Gemini 3, 4 and 6. There were seven batteries, four of which were required for the start and end of the mission and the other three for activating various pyrotechnics throughout the spacecraft. There was sufficient battery power for two hours leading up to launch, prior to which ground support equipment supplied power though umbilicals to alleviate having to use the spacecraft's limited supply on the pad. The batteries also provided sufficient power for recovery equipment for up to 36 hours after splashdown. In addition, there was an emergency power capability to operate the suit compressor for up to 12 hours after landing.

The four 16-cell silver-zinc batteries were each rated at 40 amp hours and were linked to the main bus. Normally, these batteries were used during the retrograde, re-entry and post-landing phases of the mission which occurred after the Adapter Section was jettisoned, although they could also serve as an emergency orbital power supply in the event of a failed fuel cell. For the short mission of Gemini 3, however, there were three 400 amp/hr batteries installed in the Adapter Section, which served as the primary source of electricity for the mission as the fuel cell would not be flown until Gemini 5.

The second battery system comprised three 15-amp-hour, 16-cell silver-zinc batteries, which were located in the Re-entry Module and were used to power various pyrotechnic devices, control relays and solenoids. Isolating these systems from the main bus prevented the feedback of any voltage spikes from these devices back across to the critical electronic equipment. Here again, Gemini drew on experience gained from the Mercury program, during which a number of electrical glitches were encountered. Complete redundancy in the pyrotechnic systems, right back to the power source, came from the use of diodes to isolate two pyrotechnic squib batteries from each other.

Gemini's designers also learned from Mercury by providing individual inverters on each of a number of AC powered devices, thus allowing each electrical inverter to be matched to its particular application. These were installed in the control system electronics, the inertial guidance system, the suit and cabin fans and the coolant pumps.

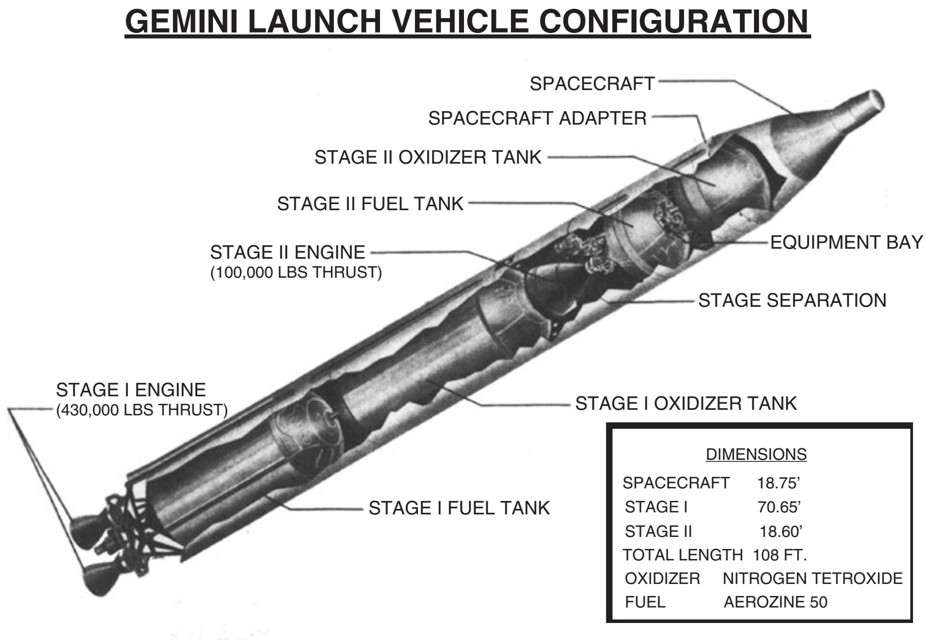


The battery module of the type used on Gemini 3.

GEMINI LAUNCH VEHICLE (TITAN II)

The Atlas launch vehicle used to launch the Mercury spacecraft into orbit was simply not powerful enough to lift the two-man, three-and-a-half-ton Gemini. With no other suitable launch vehicle in service at that time, it was decided to use the USAF Titan II Intercontinental Ballistic Missile (ICBM), built by prime contractor Martin Company. The name 'Titan' had originated in 1955 and had been proposed by Joe Rowland, Director of Public Relations at the Martin Company at that time. The name was chosen from Roman mythology, in which "the Titans were a race of giants who inhabited the Earth before men were created." [6]

Without a payload, the two-stage Titan II stood 90 ft. (27.4 m) tall with a maximum diameter of 10 ft. (3.05 m). It used storable hypergolic propellant, with the fuel (a blend of unsymmetrical dimethyl hydrazine (UDMH) and hydrazine) and oxidizer (nitrogen tetroxide (N_2O_4) and Aerozine 50) burning on contact. With a Gemini spacecraft as its payload, the total lift-off weight was about 150 tons. The first stage, measuring 63 ft. (19.20 m) in length and 10 ft. (3.04 m) in diameter, was powered by two Aerojet-General LR87AJ7 engines, providing approximately 430,000 lbs. (195,040 kg) of thrust at sea level. The stage burned out at 155 seconds into the flight, with the second stage ignited at approximately 200,000 ft. (60,960 m). The second stage was 27 ft. (8.22 m) long and also 10 ft. (3.04 m) in diameter and employed a single LR91AJ7 engine, burning N_2O_4 and Aerozine 50 to deliver 100,000 lbs. (45,359 kg) of thrust at its ignition altitude.



This cutaway reveals the main, man-rated components of the Gemini-Titan combination. Dimensions are approximations and include inter-stages. (Credit: Original illustration courtesy Peter Alway)

Though the Titan offered an immediate answer to the launch requirements of Gemini, it had never been designed to carry a manned payload, so the comfort and safety of a human crew had not been considered during its design. Changes would have to be made. Firstly, the choice of fuels was a problem. The super-chilled – and highly explosive – liquid hydrogen and liquid oxygen fuels used by Titan II in its ICBM role, with an extensive support system in place, were fine for a missile launched from an underground silo. For Titan to serve as a space launch vehicle, however, there had to be added safety so that a pad crew could assemble, pressurize and test the Titan II on the launch pad. Mixable, room-temperature hypergolic propellants were used instead, which were a lot more reliable and efficient. Using these storable hypergolic (self-igniting) propellants meant that the count-down time could be much shorter than had been the case with Mercury-Atlas. With such a tight schedule between missions, this was another factor in the choice of Titan for the Gemini program.

The main drawback with these propellants, however, was that they were highly toxic, requiring the development of special equipment and procedures to deal with the caustic chemicals, as well as keeping both the pad and the flight crews well away from exposure to fume inhalation or contact with the chemicals. Another feature of these early liquid-fueled launch vehicles was the so-called 'pogo' oscillation effect, in which the internal fuel would slosh forwards and backwards in the fuel lines due to the launch vibrations, resulting in a longitudinal 'push and pull' effect akin to that of a pogo stick, hence the name. This made the trip on a Titan a very rough ride and could add to the vehicle's vibrations as it climbed to orbit. It was certainly unforgettable for those lucky enough to ride one into space.

Once the decision was made to use the Titan II ICBM as the Gemini launch vehicle, it first had to be proven, with the first of 33 research and development flights taking place on March 16, 1962. Such was the importance of the USAF to Gemini that, just eleven days later, the USAF and NASA signed a Gemini Operational and Management Plan which detailed the roles that the Department of Defense (DoD) would play in the NASA program. The DoD would be responsible for the Titan and Atlas-Agena launch vehicles from development through to launch, as well as for range and recovery support for each spacecraft at the end of the mission. Of the 33 launches in the Titan II development program, 22 were judged as successful in qualifying the vehicle for Gemini. The final development flight took place on April 9, 1964, the day after NASA completed the Gemini 1 launch on its first Titan vehicle.

As Titan was designed as an ICBM, there had to be other modifications – termed man-rating – in addition to the change of propellant, to enable a crew to ride on a reliable and safe vehicle. These included:

Malfunction Detection System (MDS): This would sense any problems across the vital systems in the launch vehicle, with the information transmitted to the crew in the Gemini who would then decide the best course of action.

Redundant Flight Control System (RFCS): This was a backup system, capable of taking over the role of the primary flight control system in the event of a failure in flight.

Electrical System: Changes were made in the vehicle's electrical system to allow it to provide and support power for the additional systems, such as the MDS.

Weight reduction: In an effort to save weight and thus improve launch mass, the radio guidance system replaced the inertial guidance system on Titan.

Structure: In the second stage of the launch vehicle, a new truss structure was installed to hold the MDS hardware, the new flight control system and guidance equipment. There was also a new Stage II Forward Oxidizer Skirt assembly, which was required to mate the Gemini to the rocket instead of the conventional warhead.

Redundancies: In addition to the backup flight control system, redundancy in the launch vehicle hydraulics system added to the crew's safety. This came courtesy of, for example, the installation of dual hydraulic actuators for gimballing the launch vehicle's engines during flight.

Instrumentation: New instruments provided additional information for the pre-flight checkout of the launch vehicle, compatibility with the spacecraft's payload and during the flight phase.

One aspect which was evident in every Titan launch at ignition was the instant, huge volume of highly dangerous vapors billowing from the base of the rocket around the pad area. This was known to both the engineers and astronauts, in true space-age acronyms, as the "BFRC" or the "Big F****** (Expletive) Red Cloud." Clearly, anything related to Titan in the Gemini program was memorable. [7]

The famed "Big F****** (expletive) Red Cloud or BFRC, billowing from the base of a Gemini-Titan on the launch pad. In this case, the image shows the aborted Gemini 6 launch of October 25, 1965. (Courtesy Ed Hengeveld)

Man-rating the Titan

The modifications required to enable the Titan II to carry a human crew turned the former missile into what was essentially a new vehicle, designated the Gemini Launch Vehicle (GLV), whose primary objective was to place the two-man Gemini spacecraft into an orbit with the parameters of 87 nautical miles by 161 nautical miles (100 by 185.275 statute miles, or 160.9 by 298 km). The mechanics required to place the launch vehicle into the correct trajectory were very similar to those required to launch the Titan in its role as a missile, other than the inclusion of a variable launch azimuth necessary to meet conditions for the rendezvous missions later in the program. To achieve its objectives, the Titan II had to be capable of launching a payload weight greater than the Gemini spacecraft, its crew and supplies, plus the Adapter Section. Wherever possible, the modifications to the basic Titan II structure required to meet these needs would be kept to a minimum.

From a missile to a space launch vehicle

The GLV remained a version of the basic Titan II ICBM, but with significant differences between the two vehicles. These differences were defined by three classes:

1. the changes required to adapt the launch vehicle physically to carry the spacecraft
2. the changes necessary to accomplish the primary objective of placing Gemini into the required orbit, and
3. the changes and modifications made to the launch vehicle because part of the payload would be human.

Class 1 changes

The diameter of the top of the second stage of the Titan was increased to ten feet (3 m) by extending the upper structure of the stage's outer skin vertically, instead of having it tapered inwards as it would be to carry a warhead. No other significant changes were made, as the weight (mass) of the Gemini would not exceed that of a warhead carried by the ICBM and the planned trajectories to be flown would not exceed the loads for which the missile was designed. Some small refinements were made, but generally the environment and the criteria used in the structural design of the GLV were very close to that of the ICBM.

Class 2 changes

To ensure the launcher was sufficiently capable of placing the payload in orbit, the following changes were made:

- The Titan II Inertial Guidance System was deleted and replaced by a Three-Axis Reference System for the first stage and a Radio Guidance System for the second stage. On the Titan ICBM, a GE Mod III-F was used for tracking and predictions of impact, but for the GLV, a complete Radio Guidance System (GE Mod III-G) was developed, which merely required the addition of a decoder.
- The ICBM used MISTRAM and Azusa tracking equipment, but the GLV only required the MISTRAM.
- All Titan II retro and Vernier rockets were removed.
- The instrumentation system required a different voltage, so this was upgraded from a 0- to 40-millivolt system into a 0- to 5-volt system.

A Titan II research and development vehicle, number 11, was used as the basis for the proposed GLV. It was soon discovered that a payload mass increase of 1,168 lbs. (529.79 kg) was possible in the final configuration of the GLV. Then, an additional difference of 264 lbs. (119.74 kg) was discovered between a stripped Titan II with internal guidance and the final GLV configuration. This offered an increase in the amount of propellant that could be carried, through re-examining the way the propellant tanks were calibrated (nominal rather than minimum), increasing the area between the pre-valves and the thrust chamber valves used to store propellant, a more accurate loading system and maintaining lower propellant temperatures. These amendments yielded an additional 5,160 lbs. (2,340.5 kg) of propellant capacity aboard the GLV.

Class 3 changes

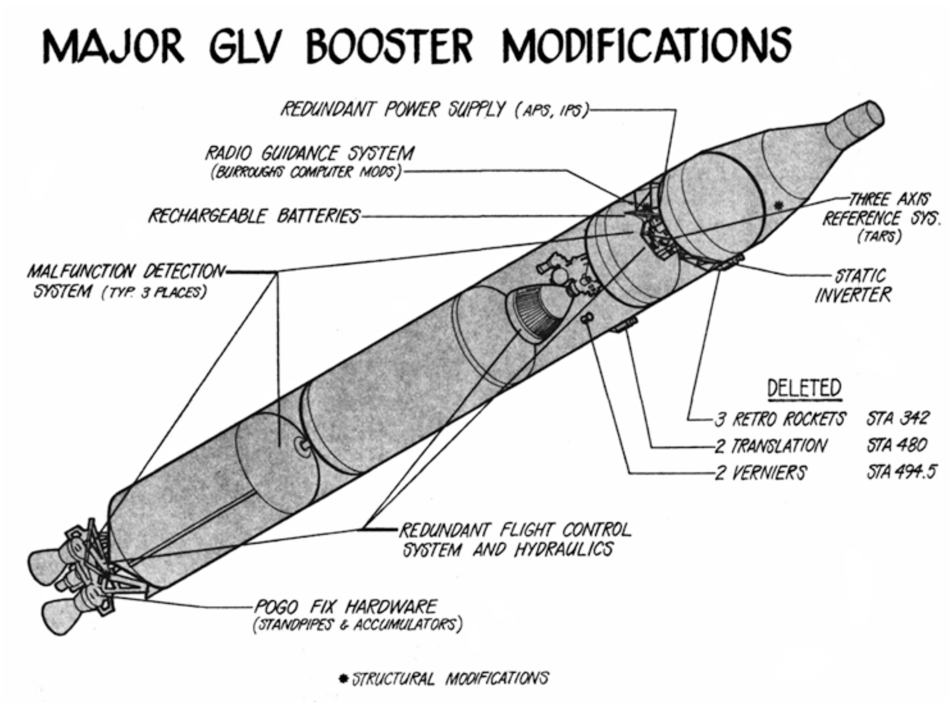
Changes completed under this class were contingent upon ensuring the safety of the two astronauts under the Man-Rating and Pilot Safety Program, which included a number of considerations. There were also a number of system design changes and additions, including:

- the Malfunction Detection System (MDS)
- features which provided flight control redundancy
- the addition of time delays in the flight termination system and
- redundancy provisions in the electrical circuitry of the flight sequencing system.

For any system or operation, the ideal result is 100 percent perfection. Realistically, of course, there always remains the possibility, however slight, of a system or hardware failure. In an attempt to minimize this possibility, a highly sensitive Malfunction Detection

System was fitted to the GLV. The aim of this system was to provide data on those parameters which could affect the safety of the astronauts and the success of the mission. In gathering this information, the fundamental question was raised about how such information would be used: In its simplest terms, what degree of automation would result? Should the information sensed by the system initiate a fully-automated ejection procedure for the crew? Or should the data be presented to the pilots, who could then decide the best course of action?

While hoping that it would never be called upon, this conundrum between automated or manual decision making was at the forefront of the aborted launch of Gemini 6 in December 1965. That episode, along with explanation of the MDS and the abort modes, will be covered in the Gemini 6 title of this series.



This diagram indicates the major systems that were ‘beefed up’ in the Titan to man-rate the vehicle for Project Gemini. (Credit: Original illustration courtesy Peter Alway)

Gemini-Titan test flights

During the planning for the Gemini missions, three test flights of the Gemini-Titan system were scheduled before operational missions could begin. The first Gemini ‘mission’ was designed to demonstrate the structural compatibility of the spacecraft and the launch vehicle. If the launch vehicle and spacecraft had been incompatible in just this basic profile, then the whole program would have been in jeopardy. Gemini-Titan 1 (GT-1 or GT-I) did not carry any operational systems and though it would be launched to orbit, separation from the second stage of its launch vehicle was not planned. It would be monitored operationally for only a short time, in order to check the overall dynamic loads on a structural shell spacecraft during the launch phase.

Gemini-Titan 2 (GT-2 or GT-II) was a suborbital mission to test the complete launch vehicle/spacecraft combination in a full test from launch, through spacecraft separation and turnaround, retrofire and a maximum heating rate re-entry and ocean recovery. The mission would evaluate a number of spacecraft systems, including: re-entry control; the retrograde rockets; parachute recovery; pyrotechnics; communications; electrical; sequential; environmental control; spacecraft displays; the Orbital Attitude and Maneuvering System and associated electronics; the Inertial Measurement Unit during launch and entry phases; non-sequential guidance during spacecraft turnaround and retro maneuvers; spacecraft recovery aids; tracking and data transmission; checkout and launch procedures; and backup guidance steering signals throughout the launch phase.

A successful flight and evaluation of the all-important heat shield would provide the evidence to go ahead and attempt the third and final test flight, this time manned, for three orbits on Gemini-Titan 3 (GT-3 or GT-III). These three missions together would qualify the whole system step-by-step for operational use from the next mission, Gemini 4. Such was the pace of the program and the overriding need to complete all twelve missions by the end of 1966 to clear the way for manned Apollo tests in Earth orbit, that everyone involved in the program hoped that each test flight would proceed smoothly. As we shall see, however, the complexity of the process and the intervention of Mother Nature threatened to upset the carefully laid plans for Gemini, even before the first mission was flown.

TYPICAL MISSION PROFILE

There can never be a ‘typical’ space mission. Each is fraught with ever-present danger, while the complex spacecraft systems and the influence of the weather can affect launch preparations, the launch itself, orbital flight, re-entry and recovery.

Following the unmanned test flights, there were two different mission profiles flown during Gemini. All ten manned Gemini missions comprised a number of key flight phases: prelaunch, launch, orbit, retrograde, re-entry, landing and recovery. These can be divided into two types of mission profile. First, there were the non-rendezvous missions, essentially the long-duration missions which featured the ‘solo’ flight of a single Gemini spacecraft. These included Gemini 3, the first manned test flight that was designed to test the compatibility of the astronaut crew in using the vehicle and determine the baseline capability of the spacecraft, as well as evaluating the food and waste systems, small experiments and observations, communications and data recording during the mission. The non-rendezvous missions would also include Gemini 4, 5 and 7. The other profile covered the rendezvous missions, generally including Gemini 6, 8, 9, 10, 11 and 12, which completed the program.

Specific mission details will be included in each of the planned titles in this series, but each Gemini mission generally followed the basic mission profile as explained below. [8]

Prelaunch

This phase of the mission began when both the spacecraft and the assigned launch vehicle (or vehicles, in the case of a rendezvous and docking mission) arrived at the launch site at Cape Kennedy, Florida. Each launch vehicle was checked and then raised on its launch pad. The system checking of both the launch vehicle and spacecraft continued and was followed by the lifting and physical mating of the spacecraft to the upper part of the launch vehicle. Following compatibility checks and tests, a number of simulations were completed to confirm that everything was working correctly and that the vehicles were ready for launch. The launch vehicle was then fueled and, at the appropriate time, the terminal countdown was started, leading (with pre-planned holds) to the point of launch.

Launch

The launch pad for Gemini missions was Pad 19 (the Atlas-Agena launches were from Pad 14, which had formerly been used for the Mercury-Atlas missions and was located a little further south along the Cape). For Gemini, the journey from pad to orbit took about six minutes. One of the first actions following lift-off and clearance of the launch tower was the roll program, enabling the vehicle to reach the correct attitude for orbital insertion. At 150 seconds into the mission, at about 230,000 ft. (70,104 m), the first stage shut down. This was followed shortly afterwards by the ignition of the second stage engines while the spent first stage was still attached. Then the first stage was separated and the climb to orbit continued. John Young likened this procedure to a "great train wreck." About six minutes into the mission, the engines of the second stage shut down, followed by the separation of the spacecraft by firing the explosive charges at the base of the Adapter Module. Gemini was now in orbit.

Orbit

With the vehicle in orbit, the crew set about checking the systems and configuring the spacecraft for orbital flight. From this point, the specific activities depended upon the individual flight plan and duration of the mission, with primary objectives normally front-loaded early in the mission, so that if the mission had to be terminated early for any reason, most of the objectives would have a good chance of being accomplished. Crew safety remained paramount at all times and throughout the mission there were constant checks on the spacecraft's systems, while the health of both astronauts was monitored and reported. Detailed accounts of this phase of each mission will be explored in the subsequent titles of this series but briefly, the ten manned orbital flights of Gemini typically included objectives such as:

Long-duration: Building up to the expected duration of an Apollo lunar landing mission (six days for lunar orbit only, eight days for early lunar landings with a single surface EVA and between ten and twelve or up to fourteen days for later Apollo landing missions). Mission planners approached the subject of extended duration by spreading the increase across four missions, starting with Gemini 3 (five hours and the main topic covered in this title), followed by Gemini 4 (four days), then Gemini 5 (eight days) and finally Gemini 7 (14 days). Flying in a spacecraft as confined as Gemini for up to two weeks was a challenge in itself without adding any other objectives to the mission, so much so that only Gemini 4, with America's first, short, 20-minute EVA, had an added major objective in the flight plan on Flight Day 1 (FD-1). Early attempts at space rendezvous with the upper stage of the Titan or with a small free-flying target were planned, while the result of a change to the plans for Gemini 6 was that Gemini 7 flew first and subsequently became the rendezvous target for the revised Gemini 6 flight plan towards the end of their record-breaking mission.

EVA: Following Edward H. 'Ed' White II's demonstration of EVA from Gemini 4, further spacewalks which were planned for other early missions were delayed to the final five flights, allowing crews to focus on the longer missions or the first docking activities. To varying degrees of success, EVA was finally accomplished on the last four missions of the program. Overall, Gemini demonstrated that basic spacewalking activities were possible, but that more complex objectives would require more specialist training, adequate body restraint and meticulous planning in order to be successful.

Rendezvous and docking: Perhaps the most important objective for Gemini was mastering the techniques of rendezvous and docking as a prelude to Apollo. Development of the techniques and early trials were accomplished on Gemini 4 and 5, but the first opportunity came with Gemini 6 (after its Agena was lost in a launch failure) in a spectacular rendezvous with Gemini 7. The first actual docking came during Gemini 8, but that mission had to terminate early before a planned EVA and rest of the flight plan could be completed due to a faulty spacecraft thruster. Various methods of ascent, rendezvous, docking and proximity operations were completed during eight of the missions and these are still widely regarded as one of the most important achievements from the whole Gemini program, with direct application not only to Apollo, but to all subsequent rendezvous and docking operations since then.

Experiments: All Gemini missions were, in effect, experiments in their own right. They were conducted only four and five years into the history of manned spaceflight operations and NASA took full advantage to extract as much data as possible from each mission. Each of the manned missions also carried a suite of scientific and technological experiments and completed a program of in-flight photography to record mission events, specific phenomena, or in support of other experiments and Earth observations. These missions offered the first real opportunity for astronauts to conduct scientific activities and operations from orbit, something that has become an everyday event in the current era of space stations.

Mission Control

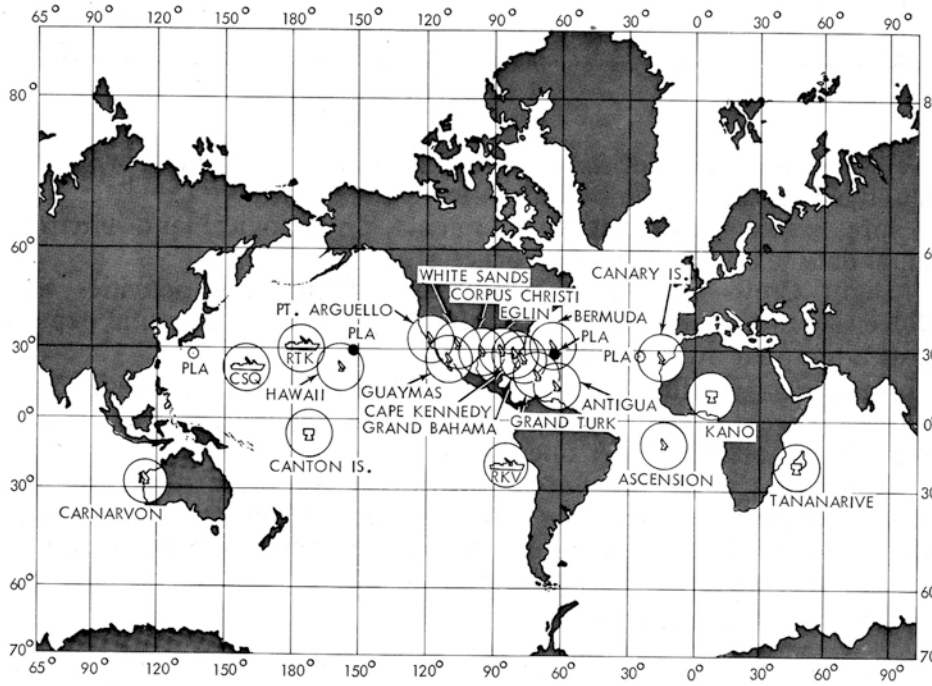
For Gemini missions 1 through 3, the original Mercury Flight Control Room at Cape Canaveral (Kennedy) was converted for use with Gemini as Mission Control Center-Kennedy (MCC-K). Shortly after clearing the tower during the launch of Gemini 4 however, control was passed to the new Mission Control Center at Houston for the remainder of the mission and 'Houston' became the main center for mission control for the remainder of the Gemini program. The experiences and skills gained from the Gemini missions at MCC-Houston helped establish the ethos and procedural rules which were so successfully transitioned into the Apollo era and continued with Space Shuttle and on to the ISS.

Each Gemini Flight Controller Team was headed by a Flight Director, who was responsible for the safety of the mission and the execution of the flight plan according to mission rules. The ultimate responsibility for the safety of the crew rested with the Command Pilot on board the Gemini. Drawing upon data from the mission control team, the support rooms and global tracking stations, the Flight Director would decide whether the mission was to continue, or whether to shorten or terminate the mission should a serious situation occur. For the longer Gemini missions, it was necessary to employ more than one Flight Control Team to handle orbital operations.

In these early days of Mission Control, digital and tonal command systems were used, with the option of routing these commands through some of the ground network stations. The Ground Operational Support Systems Network provided high-speed data for the day, using a combination of submarine cables, land lines and radio links. In the first three missions, this data was processed at the Goddard Space Flight Center (GSFC) in Maryland and forwarded to the Control Center at the Cape, prior to Mission Control Houston coming on line from Gemini 4. From then on, Goddard relayed raw data to Houston where it was processed, saving time and money, although the links between Goddard and Houston had to be created.

As Gemini progressed, so trials of the use of communication satellites such as Syncom were evaluated, while the use of the Tiros weather satellite system kept the controllers up-to-date regarding weather conditions at the launch site, as well as the primary and secondary landing sites and tracking stations across the globe.

All the data received via the tracking network and from the Control Center was processed and displayed in real-time, or at least within a few seconds of the transmission time. On board the spacecraft, the crew would tape comments at specific times, recording their activities and observations for later analysis after the mission.



The worldwide Gemini tracking network.

Tracking and communications: Tracking and communication stations spread around the world monitored each mission as it passed into their range of visibility and communications. Traveling eastward around the globe, along the Gemini ground track from the launch site, these tracking stations were sited at: Cape Kennedy (CNV); Grand

Bahamas Island (GBI); Grand Turk Island (GTK); Bermuda (BDA); Antigua (ANT); Grand Canary Island (CYI); Ascension Island (ASC); Kano, Nigeria (KNO); Pretoria, South Africa (PRE); Tananarive, Malagasy (now Madagascar, TAN); on *Coastal Sentry Quebec* (CSQ) a specially converted tracking ship stationed in the Indian Ocean; Carnarvon, Australia (CRO); Woomera, Australia (WOM); Canton Island (CTN); Kauai, Hawaii (HAW); then two other specially modified tracking ships stationed in the Pacific Ocean, *Rose Knot Victor* (RKV) and *Range Tracker* (RTK); Point Arguello, California (CAL); Guaymas, Mexico (GYM); White Sands, New Mexico (WHS); Corpus Christi in Texas (TEX); Eglin, Florida (EGL) and Wallops Island, Virginia (WLP) before the site at the Cape in Florida came back into range and the circuit began again. In support of this network, the DoD made a number of aircraft available to provide further tracking capability, with additional trajectory data handled by a pair of Missile Tracking Measurement (MISTRAM) stations – Eleuthera and Valkaria – during the powered phase to orbit. The Manned Space Flight Tracking Network (MSFTN) was fully exercised in support of Gemini for the first time in October 1964, which turned out to be just under six months prior to the first manned orbital flight.

Retrograde

Towards the end of their orbital mission, with their objectives completed, the crew turned the spacecraft around so that the large Adapter Module faced the direction of flight. Then, at a predetermined point in the final orbit, the Equipment Section of the Adapter Module was jettisoned, revealing the four retrograde rockets. The ground stations frequently uplinked data to the crew indicating their exact orbital position and ground track, so that the pilot could insert the current data into the onboard computer. From this data, the computer could determine whether the planned landing point was within the range of the spacecraft and then indicate the precise time the astronauts were to fire the retro-rockets. When they were fired, the orbital velocity was slowed sufficiently to allow the spacecraft to descend from orbit. With retrofire complete, the Retrograde Section was also jettisoned, revealing the protective heat shield to the direction of flight. At this point, re-entry began.

Re-entry

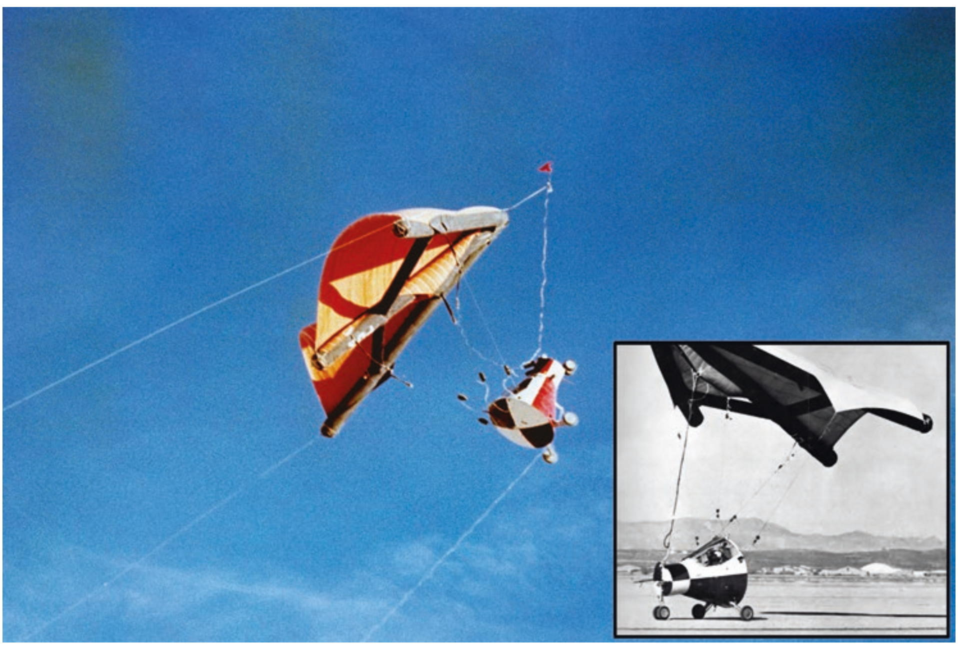
Throughout re-entry, the onboard computer assessed the flight path and directed the crew to use the attitude control jets to roll the spacecraft, taking advantage of its lifting capacity and allowing it to fly to the left or to the right, or to lengthen or shorten its descent as required. This essentially allowed the crew to ‘fly’ the re-entry to within a 10-mile (16.09 km) circle within a 28,000-square-mile (7.25 million hectares) area. Once the spacecraft reached the point where a non-lifting trajectory would carry the Gemini to its landing point, the computer instructed the crew to initiate a controlled roll of the spacecraft to eliminate the previous lifting effect on the spacecraft’s trajectory. This created higher aerodynamic drag and thus decreased the speed of the returning spacecraft to near subsonic speeds.

Landing

At about 60,000 ft. (18,288 m), a drogue chute was deployed. This was designed to slow the velocity of the spacecraft further and to stabilize it prior to the deployment of the large ring sail parachute at 10,000 ft. (3,048 m). Then, at the appropriate height, the single suspension point was amended to a two-point ‘landing attitude’ suspension by throwing a switch. This would support the spacecraft at a 35-degree nose-up angle as it approached splashdown.

Development and qualification work on the parachute system for Gemini had taken over two-and-a-half years. The Gemini landing system consisted of an 8.3 ft. (2.529 m) diameter conical ribbon drogue chute, an 18.2 ft. (5.54 m) diameter ring sail pilot chute and an 84.2 ft. (25.66 m) diameter ring sail main landing parachute. Two new concepts were proven in the operational landing of Gemini using this system. Firstly, the use of a tandem pilot/drogue parachute method of deploying the main landing parachute and secondly, the reduction of landing forces on the spacecraft structure – and by implication its two-man crew – by positioning the spacecraft into its two-point suspension mode, allowing the spacecraft to splash down heat shield end first at the 35-degree angle. This eliminated the need to incorporate shock absorption equipment or a landing bag beneath a detachable heat shield, as in the case of the Mercury spacecraft, which also contributed to the overall weight saving measures. A series of 15 high-altitude drogue parachute development drop tests were conducted, as well as 33 development drop tests using both the pilot and main chutes. These were followed by three unmanned system and ten manned qualification drop tests using Static Test Articles #7 and #4A [9]

Initially, Gemini was intended to have the capacity for a land-landing, using tri-skids on the underside of the spacecraft and a Rogallo Wing. However, this option was not taken up for the program, leaving the option of a splashdown sequence for all 11 spacecraft which returned to Earth.



The original Gemini landing method was to have been by Rogallo Wing on land, seen here during test runs prior to its cancellation from the program. (Courtesy Ed Hengeveld)

Tests on the land-landing system began in May of 1962 at the Ames Research Center, Moffett Field, California. A half-scale Rogallo Wing called the Paresev was evaluated through July of that year at the Flight Research Center, on the Mojave Desert in California. One of the pilots to check out on the Paresev was astronaut Virgil I. 'Gus' Grissom, who had been assigned to the Gemini program almost from its outset and was a contender for an early mission assignment. At the same time, drop tests of the emergency parachute systems began with the half-scale Rogallo Wing built by North American, but by December that year, these tests had proved unsuccessful and NASA requested over two dozen modifications before the tests resumed. By the spring of 1963, a series of setbacks and budget issues saw a revision of the Rogallo Wing plans for Gemini and its first operational use was delayed from the seventh mission to the tenth mission. Things did not look good for the Rogallo Wing and some at NASA pushed for dropping the concept completely, reverting to full ocean recovery. However, more tests and wind tunnel experiments were conducted during the year. By February of 1964, with only six of the 25 development flight tests of the full-scale Rogallo Wing successful, the plan to use the system for Gemini was removed from the flight schedule altogether. While it may have been a sound concept, it was judged to be a work in progress and its development would not be completed in time for Gemini. [10]

Recovery

The responsibility for recovering each spacecraft and its crew fell to the U.S. Department of Defense, who employed a flotilla of military ships, aircraft and personnel across the world to ensure as rapid a recovery as possible of the spacecraft and crew in emergency, contingency or during nominal recoveries. Primary landing sites for Gemini were located in the Atlantic and Pacific Oceans and there were a number of contingency landing sites around the oceans of the world. This ongoing support from the DoD, from Project Mercury through to Apollo-Soyuz (1961-1975) was significant but expensive and contributed to the eventual decision to incorporate the land-landing capability on future manned spacecraft such as the Space Shuttle. However, current designs (2017) for the *Orion* capsule have incorporated a combination of the preferred land-landing capability with a water splashdown as a backup capability for alternative or contingency conditions.

Once the safe splashdown of Gemini had been confirmed, helicopters were dispatched to deploy a team of Para-rescue divers, who would attach floatation collars to the spacecraft and make personal contact with the two astronauts to establish their condition. The prime recovery vessel subsequently arrived to lift the spacecraft out of the water, though the crew could opt for helicopter pick up prior to the arrival of the recovery vessel.

The post-flight series of examinations, debriefings and evaluations began on the recovery ship and continued for several days once back in the United States. These were followed by a round of press and public events before the crew members moved on to their next assignment. Some would begin the Gemini mission training routine all over again, to support or fly another mission profile.

SUMMARY

As Grissom pointed out, Gemini was a vital link between the short, one-man pioneering excursions into Earth orbit and the far-reaching manned lunar landing and exploration program of Apollo. All three were essential to each other, a step-by-step approach beginning with the basic techniques of venturing into space and exploring its challenging environment, gradually understanding what was required to survive in space and then learning to live there and perform useful and productive work at the same time. Indeed, the early success and confidence shown during the Apollo lunar missions led to continued growth through Skylab and Apollo-Soyuz, fulfilling, at least in part, a desire to use Apollo hardware for missions other than landing a couple of men on the Moon, gathering a few rocks and getting back in one piece. The objectives for Gemini were far-reaching and perhaps imposing at the beginning, having to be accomplished in a defined timescale by a specific number of missions. There would be little margin for error, so appropriate systems had to be in place to compensate for failures, setbacks and real-time changes to the plans. But from the start, it was clear that if Apollo was going to succeed in its allotted timescale, Gemini would have to do so first. Mercury may have taken the early headlines and Apollo the glory, but it would be Gemini, step-by-step, mission-by-mission, that would provide the tools to build upon the early foundations and enable Apollo to reach the lunar surface in the summer of 1969.

References

1. *Origins of NASA Names*, Helen T. Wells, Susan H. Whiteley and Carrie E. Karegeannes, NASA SP-4402, 1976, pp. 104-106.
2. Mission Control Center/Building 30, Historical Documentation, Archaeological Consultants Inc. Sarasota, Florida, on behalf of NASA, October 2010.
3. For full details of the spacecraft and systems, see **Gemini: Steps to the Moon**; NASA Gemini 1965-1966 Owner's Workshop Manual, David Woods and David M. Harland, Haynes Publishing, 2015; and Appendix 2 on page 306.
4. *Development and Qualification of Gemini Escape System*, Hilary A. Ray Jr., and Frederick T. Burns, NASA MSC, Houston Texas, NASA Technical Note TN D-4031, June 1967.
5. *Project Gemini Technical Summary*, P. W. Malik and G.A. Souris, McDonnell Douglas June 1968, NASA CR-1106, p. 173.
6. Reference 1, p. 25.
7. For further details of the development of the Titan for the Gemini program, see **On the Shoulders of Titans**; **Gemini Chronology** and **Gemini: Steps to the Moon**, as listed in the bibliography.
8. For further information on the flight profiles, see **Gemini Steps to the Moon** pp. xxxv – xxxviii.
9. *Gemini Spacecraft Parachute Landing System*, John Vince, NASA MSC, Houston, Texas, NASA Technical Note TN D-3496, July 1966.
10. *Gemini Land Landing System Development Program: Volume 1: Full-scale investigations*, by Leland C. Norman, Jerry E. McCullough and Jerry C. Coffey, NASA MSC Houston, Texas. NASA Technical Note TN D-3869; *Volume 2: Supporting Investigations*, NASA TN D-3870, both published in March 1967; also, *Paraglider, Land Landing for Gemini,* by Ed Hengeveld, X-Planes Monograph #3, HPM Publications, 1998.

2

A "clean and green" flying machine

"The only thing wrong with this one is that we haven't got a crew in it."
Astronaut Richard F. Gordon, Jr.
commenting on the success
of Gemini 1, April 1964

By adopting the lessons learned from Project Mercury, the engineers and mission planners now working on Gemini were spared the cost and time of completing extensive wind tunnel simulations and a series of unmanned test flights. Though taking the lead from Mercury in some respects, Gemini was not conceived merely to duplicate the findings from the previous program: i.e., that man could endure the flight into space, be supported to survive while there and make it safely back to Earth. With the more complicated Apollo being prepared to land on the Moon by the end of that decade, it became the remit of Gemini to bridge the knowledge gap between what had been discovered with Mercury and what still needed to be learned to achieve Apollo's goal – and in the shortest, but safest time possible. With only twelve planned missions for Gemini, there was much to achieve and explore, but very few opportunities and precious little time to achieve all that was expected of the program. With only two unmanned precursor missions to check out the hardware and compatibility before the first crew took Gemini into orbit on the third and final test flight, these missions had to perform well and deliver on their goals. Their success would be crucial to clear the way for more extensive operations in the remaining nine missions before Apollo began to fly. It seemed, at times, that no matter what the delay, Gemini had to fly with metronomic precision because all the while that the Gemini program was being prepared and flown, Apollo's countdown clock was constantly, relentlessly, inexorably ticking towards the end of the decade.

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_2

PLANNING THE MISSIONS

Determining the required number of missions to be flown was defined by the six program objectives established in the Preliminary Project Development Plan, dated August 14, 1961. [1] These objectives were:

Long-duration flights, with astronauts for up to seven days and animals for up to 14 days.
The two extended, seven-day manned flights were scheduled for the third and fourth missions (to evaluate the astronauts' capability to function in space for up to one week).[1] Then, two 14-day animal flights (for completely unique and objective physiological data) were scheduled for missions six and eight. The reason for the delay was that mission planners could not rely on the durability of some of the components in the spacecraft systems, especially the retrofire system. However, by the time the unmanned 14-day missions flew, the earlier manned missions, flying with manual back up capability, would have established the required confidence in the reliability for the longer missions.

Investigation of the Van Allen radiation belts
The first Gemini launch was planned as a compatibility test between the spacecraft and its booster, thus qualifying it for manned flight, but it would also conduct some useful science as well. The plan was to boost the spacecraft into a highly elliptical orbit of 99.4 miles (160 km) perigee and 869.96 miles (1400 km) apogee, where it would traverse the radiation belts to gather useful data for the planned later Apollo missions to the Moon.

A controlled landing
All seven manned missions under this plan would develop the controlled land-landing goal, which would require some method of allowing the pilot to be able to fly Gemini to a landing in a limited area. To soften the landing, the planners were looking towards the use of the Rogallo Wing as an option.

Rendezvous and docking
This was to be attempted on the fifth, seventh, ninth and tenth missions and would involve the Gemini docking with an Atlas-launched Agena B. One of the earliest problems foreseen was the limitation in the launch window for launching the second craft to ensure a smooth rendezvous profile.

Astronaut training
This was considered a useful byproduct of Gemini, allowing the astronauts to gain flight experience which would be useful in recycling them to later missions in the program or on to Apollo crews, providing the all-important flight experience that would be required by the more complicated lunar missions.

[1] The week before the STG report, Soviet cosmonaut Gherman Titov had spent 25 hours on the 17-orbit Vostok 2 mission, proving that a man could withstand at least a day in orbit, though he had reported nausea.

These objectives were to be achieved across ten flights, launched every two months, spread over an 18-month period between March 1963 and September 1964. If successful, they could lead to fulfilling the final objective:

An advanced program based on the Mark II design, intended to accomplish "most of the Apollo mission at an earlier date than with the Apollo program as it is presently conceived."

This was by far the most optimistic goal of this plan. If all had been achieved in earlier objectives, then a more advanced program could be implemented by adding four missions to the original ten and employing a Centaur upper stage. Following a rendezvous and docking with the Centaur, its liquid-fueled engine would boost the configuration to escape velocity on two deep space excursions and two circumlunar missions. This plan did not last long, however, because just one week later a revision was issued where all mention of a Mark II lunar mission was omitted, though the idea hung around on paper for some time.

By October 1961, revisions to the development plan gave higher priority to developing rendezvous and docking techniques, second only to that of long-duration flight and with controlled landing coming in third and astronaut training an incidental fourth. Erased from the plans were the radiation belt flights, the animal flights and the deep space sorties using Centaur. As the official Gemini History explained, Mark II (Gemini) now became the resource to "develop the technique, rather than applying it." To achieve the program's targets, there would now be 12 missions on the manifest instead of ten, still with two months separating each mission but now running between May 1963 and March 1965.

Planning for 12 spacecraft had inevitably contributed to the increasing costs of Mark II. Originally, there would have been eight spacecraft procured with two being refurbished and re-flown, but while there would now be three spacecraft refurbished in the new plan, these were only to be used as spares and not necessarily flown. The number of Titan launch vehicles had also increased, from the original ten to 15 with three serving as backups, as had the number of Atlas-Agenas, up to 11 with eight scheduled to fly, rather than four and three held as spares. [2]

The revised planning also proposed that the spacecraft should be designed as a multi-purpose vehicle, capable not only of supporting the long-duration and rendezvous objectives, but also being adaptable to other missions.

By January 1962, Mercury Mark II had officially become Gemini, with the establishment of a formal Project Office, but the planning required to meet and overcome potential problems in development, hardware, costs and goals, as well as establishing the new Manned Spacecraft Center in Houston, Texas, left the revised launch dates as little more than an educated guess. The first mission slipped to July or August 1963, but the timing between the first, second and third launches had been reduced to a few weeks, with mid-September slated for the second launch and late October or early November for the third. The remaining nine would still follow at two-month intervals. However, a budget reduction and numerous technical problems during the rest of 1962 severely threatened the program and required another rethink, although by the end of the year things were looking up. While the budget axe would remain a threat for some time to come, an immediate result of the rethink was a redefinition of the launch schedule.

In July 1962, McDonnell had proposed inserting an extra mission into the schedule (confusingly called Flight No. 0) prior to the first planned mission, replacing the proposed unmanned orbital flight. This was to be a ballistic test launch in December 1963 to investigate the capability of the spacecraft's heat shield, to gather pre-flight data on the integration of the spacecraft and launch vehicle, to run through a complete launch operation and to gather flight data on both the Titan and the Gemini from launch to splashdown. The second mission would now be an unmanned orbital qualification flight, three months later in March 1964, to be followed by manned missions every two months until the twelfth and final flight in November 1965.

A full year before the first Gemini mission flew, the sequence and objectives of the planned 12 missions changed again. On April 29, 1963, NASA Headquarters approved a revised flight schedule proposed by the Gemini Project Office (GPO). There would now be ten manned missions not 11, largely due to the ongoing problems found in the development of the Titan, but also due to the rising costs and challenges of some of the emerging technologies.

As the design of the new spacecraft progressed, it was found that far fewer Mercury-type systems would be needed. This meant developing completely new components and this, in turn, would require revisions to the expected delivery dates for the first few flight vehicles, forcing the program managers to re-evaluate the whole flight planning for the remaining missions. [3]

According to the earlier schedule, the first mission, planned for December 1963, was an unmanned sub-orbital flight to evaluate the systems and procedures before committing a crew to riding on the booster. However, in the new plan and in light of difficulties with Titan, this did not seem suitable, so the first mission would now be an orbital flight to evaluate both the subsystems in the Titan launch vehicle and the spacecraft's compatibility as a payload. Although this was an orbital flight, no separation from the Titan second stage was planned and hence there would be no recovery. Instead, after only a few orbits and an evaluation of the worldwide tracking network, the combination would burn up in the atmosphere.

The second Gemini mission had originally been planned as the first manned orbital flight, but in the new schedule this became the replacement unmanned ballistic mission originally allocated to the first mission. This was now expected to be flown in July 1964. The primary objectives of this mission were to test the heat shield of Gemini under conditions of maximum heating and to qualify all the spacecraft and launch vehicle systems for manned spaceflight.

The third mission, the first manned flight scheduled for October 1964, was originally planned as a full-day, 18-orbit manned mission, but its new role, seven months later than originally planned, was as a short systems evaluation mission of three orbits. This became the mission's official duration in June 1963 and meant that the proposed Rendezvous Evaluation Pod, planned for Gemini 3 and 4 in order to practice the final stages of rendezvous, was deleted from Gemini 3.

The remaining nine missions were now to be spaced out at three-month intervals over twenty-seven months, with the final mission flying in January 1967. The development of rendezvous techniques would be built up over nine of the ten manned missions, starting with rendezvous terminal maneuvers on Gemini 4 if the flight duration allowed. This would use a Rendezvous Evaluation Pod as a target during a planned seven-day mission (close to the eight-day duration estimation for the initial Apollo lunar landing missions). Gemini 5 was to perform the first rendezvous with the Atlas-launched Agena D target, while Gemini 6 would now attempt a 14-day long-duration mission (calculated as more than enough time to fly Apollo to the Moon, remain on the surface for a few days and get back to Earth). Gemini 7 through 12 would each be three-day missions and by the close of the program, the experience of rendezvous would be expanded upon sufficiently to be ready to pass the baton to Apollo. Gemini 2 through 6 were planned for parachute landing in the ocean, while the land-landing using the Rogallo Wing remained the option for Gemini 7 and the rest of the program, for now.[2]

According Robert R. Gilruth, Director of the Manned Spacecraft Center, in a Management Council meeting on April 30, 1962, the day after NASA Headquarters approved the new flight plan, that approval meant that “Instead of being merely a transition between Mercury and Apollo, the Gemini program now actually involved the development of an operational spacecraft.” This was expanded upon further by Manned Spaceflight Director D. Brainerd Holmes, in a memo to Associate Administrator Robert C. Seamans Jr. three days later, in which he explained that by using the most up-to-date technology on Gemini, rather than simply modifying the older Mercury design, there would essentially be a new spacecraft. “Gemini would have extensive and most useful applications on Earth orbit space operations,” he wrote, eventually being used “as a resupply vehicle for future space stations.” Clearly, there remained the desire, even plans, to extend Gemini beyond the current program, supporting the effort for Apollo in the areas of mission training, development of systems and pre-flight checkout, with the hope that Gemini might eventually become the workhorse of the American space program. Unfortunately, there were underlying issues – such as the cost of the Vietnam war and the fact that Apollo’s lunar mandate would remain the funding priority for NASA – which would prevent this becoming a reality.

Preparing for Gemini 1

On June 27, the launch azimuth for the first Gemini mission changed from 90 degrees to the 72.5 degrees previously used during the Mercury missions, which offered better coverage from the tracking network. Charles W. Mathews, the Acting Manager of the Gemini Project Office, stated that Gemini 1 was to be a full production shell ‘spacecraft’, including the shingles and heat shield, but would not be a fully-operational vehicle. Equipment onboard included a simulated computer, an Inertial Measurement Unit (IMU) and Environmental Control Systems (ECS) installed in the Re-entry Module. As the spacecraft was not going to be separated or recovered, simulated equipment was placed in the Adapter Module, while sensors throughout the spacecraft would record pressure, vibrations, temperatures and accelerations. [4] These instruments were installed on pallets in place of crew seats, but on July 21 during Spacecraft Systems Tests (SST) at McDonnell, a range of problems befell the test program and delayed the procedure by two weeks. These tests resumed on August 5 and were successfully completed by August 21. [5]

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[2] The land-landing capability was removed from Gemini flight planning in February 1964.

During July, the Gemini Project Office reviewed the possibility of providing a backup spacecraft to the first Gemini flight. The delays to the Titan launch vehicle were worrying and adding a third test flight would increase the flight program (and add to the budget) from 12 to 13 missions, but it also offered an extra safeguard against a failed inaugural mission should a problem occur with the Titan. This new mission, if flown, would use a boilerplate Re-entry Module fabricated by local contractors and modified at MSC (where it was originally planned for floatation tests) and an Adapter Module specially made by McDonnell fitted out with telemetry equipment and wiring harnesses. This plan was approved by Headquarters in August at a cost of $1.5 to $2 million. The new mission would be designated Gemini 1A (or GT-1A) and in the Planning Board meeting of September 6, it was decided that its mission would be identical to Gemini 1 (or GT-1), but would only be flown if the first mission failed.

The Re-entry Module hardware for Gemini 1A left for the Cape on December 13, 1963, arriving there three days later. [6] The Adapter Module arrived on January 24, 1964. However, by the following month, the concerns over the Titan had diminished and had rendered the inserted flight unnecessary. With growing confidence in the launch vehicle, Mission 1A was scrubbed from the manifest on February 17, 1964. [7]

Titanic troubles

There were a number of issues with the potential to delay the introduction of the new spacecraft, the most serious of these being the challenges in qualifying the Titan II rocket for human flight. The issues with pogo oscillation and the lack of thrust of the second stage remained valid concerns for NASA for some time. It also worried the air force, who had plans for the Titan and its upgraded variants beyond its ICBM role (together with the Gemini spacecraft, termed 'Blue Gemini') for their own manned space agenda, in particular for the Manned Orbiting Laboratory (MOL) Program in which pairs of USAF-trained military astronauts would fly on Gemini spacecraft for the ascent and recovery during 30-day classified reconnaissance missions. Therefore, this first Gemini flight would not only create an opportunity to test the fixes put in place to man-rate the vehicle, it would also integrate the USAF and Martin Company teams into an operational Gemini team led by NASA and would give the USAF useful experience for their own subsequent program. There was a lot riding on this first mission, not only in the instrument pallets located in the crew stations.

THE 'FLYING MACHINE'

Outwardly, Gemini 1 resembled all the other Gemini craft. It was conical in shape, comprising the Adapter Module and the Re-entry Module which would normally house the flight crew, but with subtle internal changes implemented to meet the specific, unique demands of this inaugural flight.

On each of the Re-entry Module's two hatches, a pair of heat sensors were installed between the inner and outer window panes. On manned flights, these were the only visual observation windows on the spacecraft and would be used by the crew for viewing critical phases of later missions, such as rendezvous and docking as well as Earth observations and photography. Therefore, it was imperative to monitor the temperatures on the outer

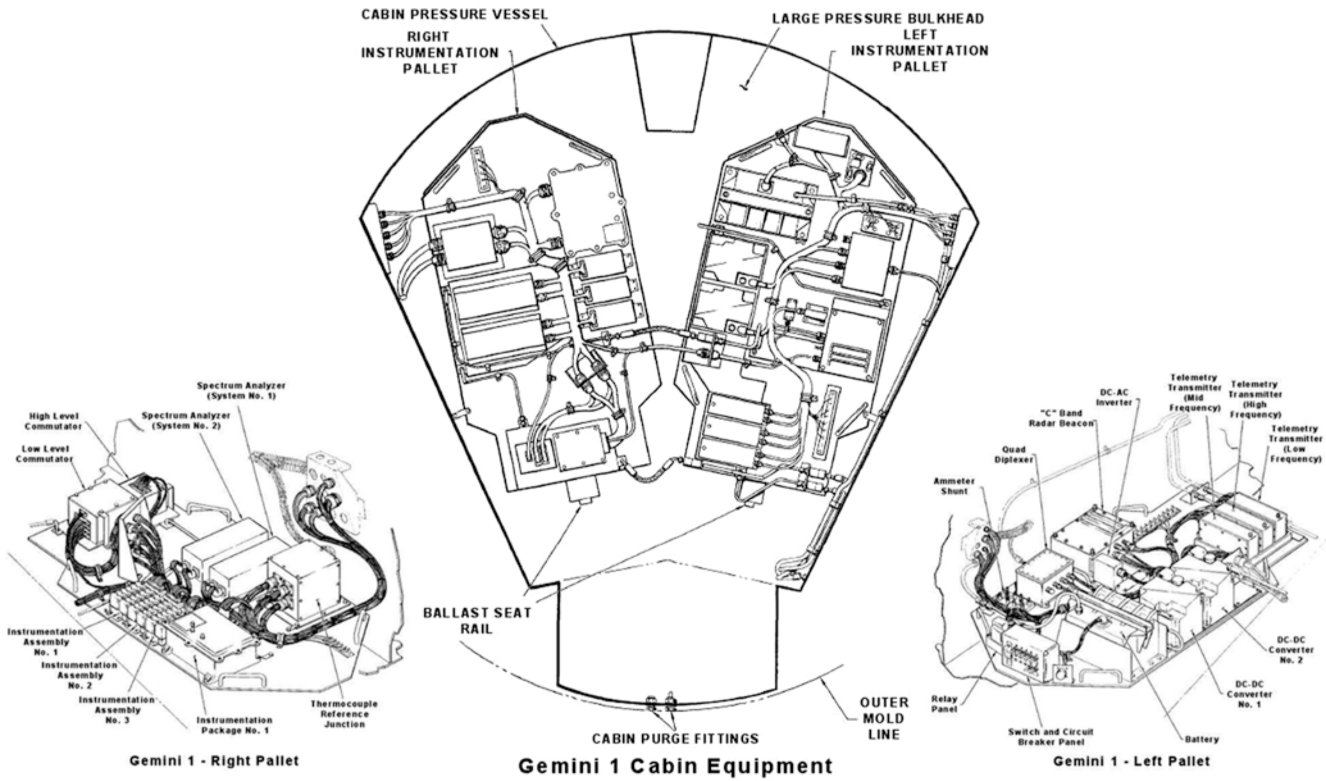
The first stage of the Titan II arrives at Launch Pad 19. (Courtesy Ed Hengeveld)

pane during this flight to show that the design could stand up to the rigors of spaceflight, with only two flights before a crew occupied the flight seats on a real mission.

In the Adapter Module, equipment mounts were installed in the vehicle to simulate the actual mass for each piece of equipment. On this flight, the Adapter Module served only as a structure to attach to the launch vehicle and as there were no plans to attempt to recover the vehicle, both the retro-rockets in the Retrograde Section were dummies. The base of the Adapter Module on this spacecraft featured an aluminum ring, which was fixed to a matching ring on the top of the launch vehicle by means of 20 bolts. On subsequent flights, this connection would be severed by explosive charges, separating the Adapter Module from the Titan upper stage. This would cause some problems on later flights due to the jaggedness of the separation and would be a concern with regard to the safety of an astronaut on EVA.

Instrumentation and systems

In place of the two astronauts and their ejector seat couches, Gemini 1 was fitted with a pair of instrumented pallets inside the crew compartment, purged and sealed for flight. Pallet 1 contained 212 lbs. (96.16 kg) of instrumentation and Pallet 2 housed a further 188 lbs. (85.28 kg), together with 892 lbs. (404.61 kg) of ballast. Throughout the spacecraft, engineers fitted data pick-up devices to measure the sound levels and acoustics within the cabin. [8]



The location of the two instrumented pallets flown on Gemini 1, replacing the command pilot and pilot for this first unmanned flight of the Gemini-Titan vehicle.

The palleted instrumentation included numerous pressure transducers, temperature sensors and accelerometers. This instrumentation became the monitoring system for the health of the spacecraft throughout mission. It was planned to take a total of 104 measurements of the temperature, acceleration and pressure levels. For this, there were 14 temperature, two acceleration and one pressure measurement device located in the Re-entry Control Section; 29 temperature, nine acceleration and six pressure measurement devices housed in the Conical Section; and 36 temperature, five acceleration and two pressure measurement devices housed in the Adapter Module. All the pressure measurements were to be made inside the compartments and all the data would be telemetered to the ground during the flight as there would be no recovery.

In addition to the instrumented pallets and the vehicle's own network of nerve-ends, the *Environmental Control System* was designed to establish and maintain differential pressures between the interior of the crew compartment and the ambient pressure. The spacecraft's *cooling system* featured a number of cold plates installed on the instrument pallets in the cabin, upon which equipment that requiring cooling was fixed. The *communications system* on Gemini 1 included a C-band radar beacon, a phase shifter, a DC-AC inverter, the C-band antennae, three telemetry transmitters and a single UHF antenna. A single battery and several control relays and interconnecting wiring acted as the *electrical power system*.

All other functional systems, which were not required for this first test flight but were necessary for structural reasons, were simulated with dummy packages of the same mass as the flight components that would be used on the manned flights. Only two of the three spacecraft-to-ground umbilicals were active for GT-1. These were the electrical umbilical used for control circuits linked to the Blockhouse and the coolant umbilical designed to test the actual equipment disconnect system.

The fabrication and testing of the Gemini 1 spacecraft, together with its designated Titan launch vehicle, is detailed in Table 2.1.

Planning for flight

Gemini 1 would not only test the integrity of the launch vehicle and spacecraft, but also the launch pad used to dispatch the vehicles into space. The launch from Complex 19 at Cape Kennedy was at an azimuth (direction) of 72 degrees, from which the Titan would insert the unmanned Gemini into an elliptical orbit of 99 miles (159.29 km) by 183 miles (294.44 km). Once GT-1 was safely in orbit, the tracking of the spacecraft would be conducted by NASA's worldwide network until the electrical power aboard the spacecraft ran out, which was expected to be towards the end of the first orbit. The tracking stations available on this first mission were: Cape Kennedy; Bermuda; Australia; Point Argüelles, California; White Sands, New Mexico; and Eglin AFB, Florida. Predictions of the spacecraft's orbital life were difficult to determine, according to NASA, but it was expected to last anything from just a few hours to as long as three weeks. A more accurate estimate would be possible once the vehicle was in orbit.

Categorizing mission objectives

Every mission into space is assigned a number of objectives, categorized as primary and secondary, to ensure that the mission is successful in its goals. During the early years of the Gemini program, these were designated as *First Order Objectives* and *Second Order Objectives*. For this first Gemini mission, all the spacecraft and launch vehicle systems were also categorized as either *Primary* or *Secondary*.

Table 2.1 Gemini 1 Vehicle Manufacturing and Testing History

GEMINI LAUNCH VEHCLE GLV-1	
Event	**Date**
Start major welding of propellant tank of Gemini Launch Vehicle at Denver	1962, September
Delivery of GLV propellant tanks to Baltimore	1962, October 10
Completion of GLV assembly	1963, May 21
Completion of GLV horizontal tests	1963, May 27
GLV Erected in vertical test facility	1963, June 9
Power applied to GLV	-
Completion of GLV Subsystems Functional Verification Tests	-
Completion of GLV Combined Systems Acceptance Test	1963, October 4[1]
Inspection of GLV by the Vehicle Acceptance Team (VAT)	1963, October 8[1]
GLV Department of Defence Form DD-250 – Material Inspection and Receiving Report (MIRR) completed	1963, October 12
GLV delivered to the Eastern Test Range, Florida	1963, October 26
GLV erected at Launch Complex 19	1963, October 29
Power applied to GLV	1963, November 13
Completion of Subsystem and Combined Systems Tests	1964, January 21[2]
Tanking exercise	-
Spacecraft mated to GLV	1964, March 5
Joint Combined Systems Tests	-
Countdown practice exercises completed included the Wet Mock Simulated Launch.	1964, April 2
Final Status Simulated Flight Test	1964, April 5
LAUNCH	1964, April 8

Notes: [1]GLV-1 was not accepted following the first CSAT on September 6, 1963, or the VAT inspection on September 11, 1963

[2]Mission was postponed on November 8 because of a malfunction in the secondary autopilot; it was postponed again on November 9 for a malfunction in the new autopilot

Data obtained from Aerospace, *Gemini Program Launch Systems Final Report* and Martin, *Gemini-Titan II Air Force Launch Vehicle Press Handbook* as presented in Appendix 3, Table A, *Project Gemini, a Chronology* NASA SP-4002, 1969 p 277-278

GEMINI SPACECRAFT S/C#1	
Event	**Date**
Equipment installation	-
Mating of the Re-entry and Adapter Sections	-
Systems Assurance Tests	-
Environmental Control System validation	-
Simulated Flight Test	-
Altitude Chamber Test	1963, September 23
Shipped to ETR	1963, October 4
Complex 19/Electrical Interface Integrated Validation test (EIIV) and G&C	1964, March 3
Mechanical mating of spacecraft with launch vehicle	1964, March 5
Joint Combined Systems Test	-
FCMT/ Final Systems Test	-
Wet Mock Simulated Launch Demonstration	1964, April 3
Final Simulated Flight Test	1964, April 6
LAUNCH	1964, April 8

Data obtained from Appendix 3, Table D, *Project Gemini, a Chronology* NASA SP-4002, 1969, p. 281

First Order Objectives: These were goals whose satisfactory completion was mandatory for the mission to be classed as successful. Any malfunction of systems in the launch vehicle, spacecraft, the ground equipment, or instrumentation which might jeopardize the achievement of these objectives would be sufficient to hold or cancel the flight by the order of the NASA Operations Director. Such malfunctions could also lead to the early termination of the mission by the Flight Director if they caused any violation of the safety rules, until a fix could be performed, or the objectives could be postponed and reassigned later in the mission or to a subsequent flight.

Second Order Objectives: These objectives were classed as desirable but not mandatory for mission success. Malfunctions jeopardizing these objectives, the safety of the crew and vehicle, could cause a hold or cancellation of the mission at the discretion of the NASA Operations Director, or termination of the mission by the Flight Director.

Primary Systems: The definition of the priority of systems performance was those for which satisfactory performance was required in order to attain First Order mission objectives. Malfunction of these systems during the countdown would require a hold or cancellation of the mission, or possible early termination of the flight during the mission.

Secondary Systems: These were systems that were not functionally required to meet the First Order mission objectives. A hold or cancellation of the mission due to malfunction of these systems was at the discretion of the NASA Operations Director, or by the Flight Director during the mission.

The stated primary (First Order) objectives for this first flight of Gemini were: [9]

A. To demonstrate Gemini Launch Vehicle (GLV) performance and flight qualify the vehicle subsystems for future Gemini missions.
B. To determine exit heating conditions on the spacecraft and launch vehicle.
C. To demonstrate the structural integrity and compatibility of the spacecraft and GLV combination from launch through orbital insertion.
D. To demonstrate the structural integrity of the Gemini spacecraft from launch through orbital insertion.
E. To demonstrate the ability of the GLV and ground guidance systems to achieve the required orbital insertion conditions accurately.
F. To monitor the switchover circuits as installed on the GLV to evaluate their sufficiency for mission requirements. Also, to demonstrate the switchover function, if anomalies occurred within the primary hydraulic or autopilot systems that would require the use of the secondary hydraulic or autopilot systems.
G. To demonstrate the Malfunction Detection System (MDS).

The secondary objectives (Second Order) for this mission were:

A. To evaluate operational procedures used in establishing GLV trajectory and engine shutdown or cutoff conditions.
B. To demonstrate the performance of the launch and tracking ground network.
C. To verify orbital insertion conditions by tracking the C-band beacon in the spacecraft.
D. To provide training for flight dynamics, guidance switchover and MDS flight controllers.
E. To demonstrate the operational capability of pre-launch and launch facilities.

Static test firing

With the mission plan designed and its priorities categorized, it was finally time to put all the work to the test and fly the mission, starting with the final preparations of the hardware down at the Cape. The Titan booster assigned to the first Gemini launch had been delivered to the Eastern Test Range in Florida on October 26, 1963 and was installed at Pad 19 three days later, with power applied on November 13.

On January 7, 1964 (MSC Release 64-4), NASA announced that the two stages of the first Gemini-Titan launch vehicle would be statically test fired to evaluate system performance no earlier than January 10. However, cold weather at the Cape at the time affected the temperature of the start cartridge used to initiate the test and resulted in a postponement.

On January 21, 1964, an important milestone in the program was finally achieved when both stages of the Titan were statically fired for 30 seconds each. This was a valuable test of the performance of the vehicle (including the fueling), including an accurate 300-minute countdown replicating the actual launch process, initiating engine start and shutdown commands, monitoring guidance control and trajectory and verifying thrust generation by sending engine gimballing, as it would during the actual flight.

Both the first and second stages of the GLV-1 were installed side-by-side on separate mounts for the test. At T–0, the command to open the propellant lines on the first stage was initiated. The fuel and oxidizer both ignited upon mixing, sending the thrust blasting out of the twin engine-nozzles and building to 430,000 lbs. (1912.7 kN). After 30 seconds, an electrical signal stopped the first stage operation and sent a command to begin the flow and ignition of the similar fuels in the adjacent second stage, which built up to a thrust of 100,000 lbs. (444.8 kN). Then, again after just 30 seconds, that stage was also shut down via a signal from a ground computer, replicating a situation planned for the actual flight.

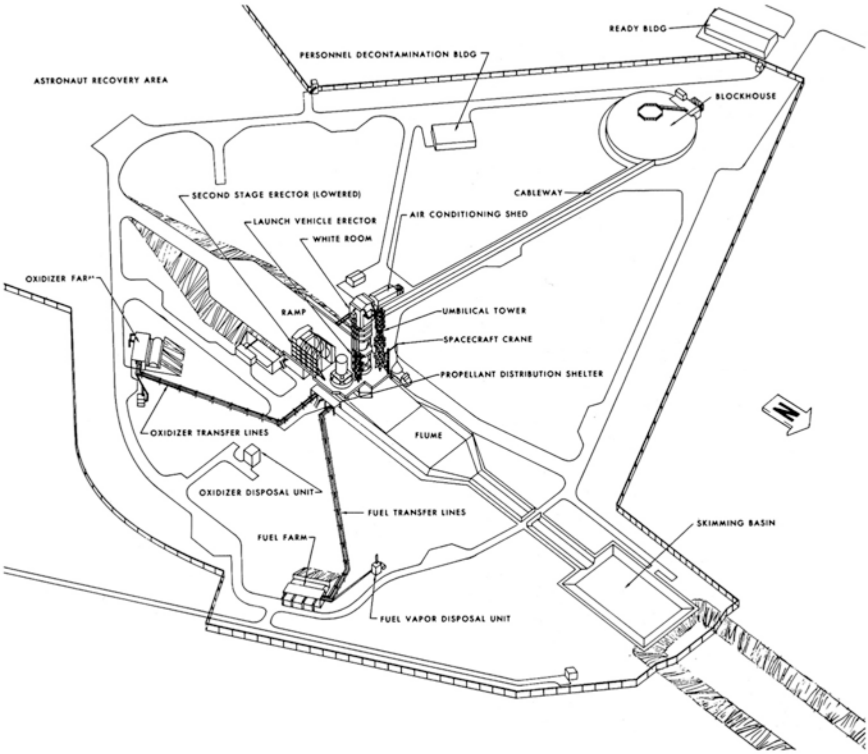
Shortly after the test was completed, Charles W. Mathews, the Gemini Program manager at MSC, commented that “Early indications show the static firing as a success; however, the final report will not be available until after a complete study of the collected data.” [10]

A PAD FOR GEMINI

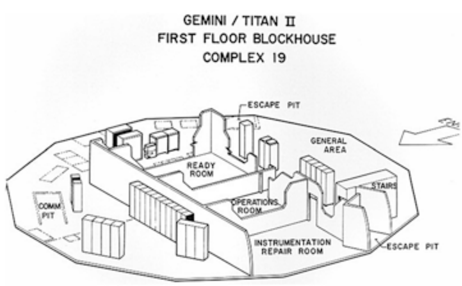
The facilities at Launch Complex 19, Atlantic Missile Range, were designated as the primary launch pad for the Gemini program.

History of Pad 19

The contract to construct the complex in support of the Titan I was awarded on April 23, 1956. Construction began on February 18 the following year and the work was completed in July 1958. The air force accepted the complex on June 16, 1959. The pad featured a horizontal-to-vertical erector system to install the missile on the launch pad. The first of 15 Titan I launches occurred on August 14, 1959, with the final launch completed on January 29, 1962. Shortly after this final launch, Complex 19 was transferred for use with space launches. Conversion of the pad to support the Titan II launches of Gemini was carried out between 1962 and 1963, with the first Gemini-Titan launch occurring on April 8, 1964. The twelfth and final launch came on November 11, 1966, after which the launch complex became inactive. Launch Complex 19 (LC-19) was deactivated on April 10, 1967, but the



Launch Complex 19, Cape Kennedy, Florida.



The Pad19 Block House.

service tower and umbilical were not demolished until May 30, 1977, more than ten years later. In September 2003, the former White Room from the pad erector was restored and relocated to the Rocket Garden at the Air Force Space and Missile Museum at the Cape Canaveral Air Force Station (CCAFS). During 2012 and 2013, the launch pad and the remaining elements of the erector were finally demolished. [11]

Modifying the Launch Complex for Gemini

The integration of the launch pad and Gemini Launch Vehicle Support Area at the Atlantic Missile Range was the responsibility of the Martin-Marietta Corporation. The design of the new and modified facility was completed by Rader and Associates of Miami, Florida, while the physical construction was completed by the Army Corps of Engineers. The modifications to existing facilities included:

- Fitting an air-conditioning system to the existing Blockhouse.
- Doubling the size of the Ready Room to house NASA, McDonnell and Martin personnel.
- External north end of the launch dock.
- A complete vehicle erector, addition of a white room, a second elevator and a spacecraft hoist system.
- A second-stage erector and the relocation of existing work platforms.
- An umbilical tower to service the complete vehicle; and extending the height to accommodate two additional booms for the spacecraft.
- A second-stage umbilical tower and the relocation of existing booms.
- The enlargement and rearrangement of the flume channel to allow a quicker runoff of expended fuels.
- A LOX (Liquid Oxygen) holding area to be used as a storage area for the spacecraft Aerospace Ground Equipment (AGE) service carts.
- Modification of the south road at the pad to accommodate fuel and oxidizer holding areas.

In addition to this modification work, a number of new facilities were added to LC-19. These included: a new road located at the north end of the pad and running north to south, for the delivery of LH_2 to the spacecraft when on the pad; an oxidizer holding area; a fuel holding area; a decontamination building; and an air-conditioning facility for spacecraft servicing. There were no new requirements in the launch vehicle support area, other than a components-cleaning facility that was provided by the Air Force Missile Test Center (AFMTC) for use by all contractors. Martin-Marietta installed all the AGE at Complex 19 and in the Launch Vehicle Support Area, but each agency providing such instrumentation for installation was responsible for the checkout and maintenance of that equipment throughout the Gemini program.

The selection of AGE for Gemini was influenced by the choice of both the Titan II as the primary launch vehicle and Complex 19 as the main launch site at the Cape. Of the 208 AGE control points at the launch complex, 143 were associated with Titan equipment and were used "as is." There were 33 Titan-modified control points and 32 Gemini-specific control points. The Ground Instrument System at LC-19 consisted of a telemetry ground station, data recording equipment, signal conditioning, power monitoring and control, time code coordination, control console and associated patching and cabling equipment. The system installed at LC-19 allowed for flexible recording systems, for data to be captured by either umbilical or transmitted telemetry links.

Gemini on the pad

At Pad 19, with the pad erector laying horizontally, the Titan II launch vehicle was rolled on tracks through an open door located at the top (roof) of the White Room and along the length of the erector. Once secured, the erector was then raised to a vertical position allowing the launch vehicle to be fixed to the launch base. Once vertical, work platforms in the erector were placed around the vehicle to give access on several levels. Prior to the launch, the erector was lowered back to its horizontal resting position.

After the Gemini spacecraft arrived at Pad 19, it was hoisted from the ground by means of a crane structure extending from the top of the large roll-up door on the side of the White Room. This area, which received its name from the fact that it was painted white on the inside, was an environmentally-controlled workspace in which the Gemini was attached to the top of the Titan and where the final processing for launch was completed. Dust and debris were kept to a minimum, as far as possible.

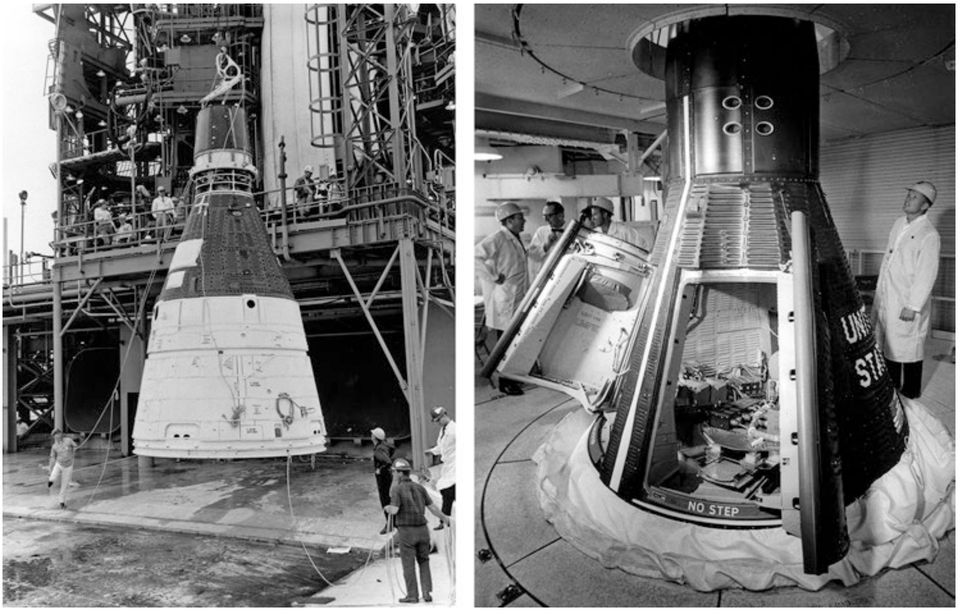
The philosophy for checking out the Gemini launch vehicle involved a decentralized approach, in that every major airborne system had an equivalent set of ground equipment associated with it. During checkout, each ground system set was capable of operating on its equivalent airborne system virtually independently of the other equipment. During the countdown phase, the launch control equipment coordinated all operations performed by the checkout equipment. Most of this was manually operated, with automated operations only applying to critical events or time periods. This was particularly important given that all the redundant flight controls and hydraulic components had been incorporated into the Gemini launch vehicle.

Control of the launch was via the Master Operations Control System (MOCS), as well as other related equipment such as the closed-circuit TV system and the community time display board. The MOCS provided time coordination during the checkout phase of the launch vehicle, as well as for remote facilities such as the water system and erector. As various built-in timing checkpoints were reached in the countdown, the MOCS displayed the state of readiness for the entire complex. Then, using a series of ‘hold-fire’ and ‘kill’ signals, the option to continue or inhibit the launch at the predetermined T–0 point could be assessed.

Pre-launch preparations

For a new spacecraft and a new launcher intended to take men into space, it is remarkable how little flight testing was done with Gemini prior to the first crew strapping themselves into the vehicle. It is also remarkable, in light of this, how smoothly the launch processing sequence progressed to get the first Gemini off the pad in the spring of 1964. This was explored in-depth in NASA’s 1977 official history of the Gemini program and is summarized here. [12]

Tests on the Titan booster and the spacecraft at Pad 19 finally began on March 3, 1964. At this point the two were still not mated, but the Titan destined to launch the first Gemini into orbit had recently completed a successful series of systems checks. Precariously hanging above the rocket, on a tripod in the White Room atop the launch vehicle erector, was the Gemini 1 spacecraft. The White Room surrounded the spacecraft until a few minutes prior to lift-off, to ensure that the area and crew compartment were as clean as possible during launch preparation and crew entry prior to launch. Aside from the color of the



[Left] March 5, 1964: The Gemini 1 spacecraft is carefully hoisted off the ground at the base of Pad 19 at Cape Kennedy for mating to its Titan II launch vehicle.[Right] Gemini 1 in the White Room Pad 19. In the background receiving early first-hand experience of Gemini launch pad procedures are (from left) astronaut Elliott See, engineer Guenter Wendt the McDonnell Aircraft Corporation pad leader, with astronaut Neil Armstrong far right. Nine months later, Armstrong and See would serve as the backup crew to Gordon Cooper and Pete Conrad for Gemini 5. (Images courtesy Ed Hengeveld)

walls, its name also derived from the fact that every worker entering the area was required to wear white overalls, protective hats and foot gear. The White Room featured four working levels and the crane, capable of hoisting five tons, that was used to move the spacecraft onto the top of the Titan's second stage. The environmentally-controlled area for the spacecraft and its upper booster was maintained at 72 degrees F (22 degrees C) and a relative humidity of fifty percent, compared with the humid and changeable atmosphere and Floridian weather at the Cape.

The original plan was to launch Gemini 1 on March 29 and a pre-mate systems test on March 4 had indicated that the spacecraft was indeed ready for mating the following day. This was delayed slightly following slight damage to the upper dome of the oxidizer tank on the Titan booster, caused by a McDonnell worker dropping a wrench onto the tank. Fortunately, plastic sheeting protected the dome from more serious damage, but nevertheless the wrench left a 0.375-inch (0.95 cm) scratch on the dome. The depth of this scratch in the steel structure of the tank was measured at 0.0015 inches (0.0038 cm) which caused some concern, considering the steel structure where the wrench hit was a mere 0.64 inches (0.16 cm) thick. The affected area was inspected and burnished to the depth of the scratch, but this polishing required further testing to confirm the structural integrity of the metal and tank and it was this that led to the short delay.

Following the mechanical mating of Gemini 1 to its booster, it then had to be electrically connected and tested for compatibility. It took workers from March 8 until March 13 to confirm that there were no problems between spacecraft and booster.

Small niggling problems had plagued the program, however, delaying the processing flow further. All this meant that the first of three interface tests could not begin until March 12, three days later than planned. When this first test was tried it had to be abandoned, resulting in another delay of four days. The next attempt on March 16 proceeded smoothly, allowing the second test to be conducted immediately after the first in order to try and catch up lost time. Unfortunately, a procedural error forced that second test to be aborted. When the test was tried again on March 19, the circuitry that controlled the actuators – and which in turn gimbaled the Titan engines in flight – revealed potential problems. The dry run conducted the following day gave the same result. Clearly, this would have to be resolved before the third interface test was attempted. This fault was finally traced to erroneous test equipment, confirmed in yet another, further test. Due to the time lost, it was decided that the dry run on March 20 had provided sufficient data for the third official interface test to be scrubbed. The outcome of all this was that a series of tests which should have taken five days had actually taken over two weeks, forcing the launch to be delayed to April 7 at the earliest.

As the month of March closed, things progressed a little more smoothly at Pad 19. A combined systems test and simulated flight on March 27 passed without incident and by the end of the month, all the 'non-flight' parts on the Gemini Launch Vehicle-1 (GLV-1) installed for the move from the McDonnell factory to the Cape had now been removed and replaced with flight equipment. The instrumentation designed to study the effects of pogo oscillation on the vehicle when it flew with a Gemini spacecraft on its nose had also been installed.

Propellant loading was scheduled for the evening of March 31, but as the area was being cleared prior to starting the hazardous operation, smoke was observed pouring out of one of the important switches on the pad, caused by a transformer and switch motor burning out. This switch was designed to transfer the launch complex systems to an auxiliary power supply in the event of a commercial power failure. If there had been a propellant leak, the safety rules required the pad to be deluged with water, but as the automatic switch was burned out, making the system inoperable, this was not triggered. A search was on to find replacements quickly, but as there were few spares for those parts readily available at the Cape, it took some time to locate the replacement parts. Fortunately, a spare transformer was eventually found and a motor was borrowed from the blockhouse, but it meant yet another day had been lost in the process.

On March 30, 1964, NASA released the dates of the planned mission for Gemini 1, suggesting that it would not occur before April 7 at the earliest pending further tests and reviews. [13]

The next operation was a complete mock countdown and simulated launch, providing the launch team and controllers with additional experience in lieu of the real launch a few days later. Propellant loading finally took place on the evening of April 2, taking four hours and passing without incident. The countdown began early the next morning at 05:00, but the count was halted two hours later for ninety minutes as a layer of warm air settled above a layer of cooler air over the pad. Had there been a propellant leak, this would have prevented the dissipation of toxic fumes away from the ground. Once the layers of air had begun to break up the count resumed, proceeding to T–0 despite a few minor problems, at which point the engines would have ignited if it had been a live launch. Only a procedural error had marred events and following a vibration test on the launch vehicle, the propellant tanks were drained, a task which took five hours to complete, an hour longer than it had taken to fill them.

On the afternoon of April 3, after the test, seven members of the Spacecraft Flight Readiness Review Board (SFRRB) met in the conference room of the Engineering and Operations Building, which served as the Headquarters for MSC Operations in Florida, to review the data from the simulated countdown and plan the formal launch of the mission.[3] The review had a number of McDonnell and MSC system engineers on hand to answer questions and offer any assistance to the board in their deliberations. The board's remit covered the evaluation of all waivers, deviations, modifications, discrepancies and any work done at the Cape. Despite minor outstanding issues with a circuit breaker, which was awaiting qualification but deemed flight worthy, the board agreed that all systems on GLV-1 were ready for flight pending the result of a final systems test, a simulated flight planned for April 5.

After a review of the flight readiness of Titan on April 4 by the USAF, the simulated flight did indeed proceed without incident the next day, clearing the way for the final approval for launch of Gemini 1. Shortly after the simulated flight on April 5, Walter C. Williams convened the Mission Review Board, made up of spokesmen from every group involved in the upcoming mission, then pooled them for their readiness for launch. Everything was reported favorable and all systems were "Go" for launch. At that Sunday meeting, Williams announced that the launch of Gemini 1 was scheduled for no earlier than 11:00 on Wednesday April 8, 1964, having slipped 24 hours due to minor delays.

The final hurdle was cleared two days later, on April 7, when the SDD Status Review Team took a final look at the launch vehicle and recommended a "Go" for launch. That information was passed to the Flight Safety Review Board shortly afterwards, who in turn approved GLV-1 for launch and flight the next day.

At last, just two years and four months after its formal initiation, Gemini was about to fly.

THE FIRST GEMINI FLEDGES THE NEST AND FLIES

As the launch day dawned, there was a lot resting on the success of this very first Gemini-Titan mission. Across NASA's field centers, particularly in Houston and down at the Cape, it was a tense time as the countdown clock methodically ticked down towards the moment of truth. The first launch in the all-important Gemini program was tantalizingly close. As this was the first of only two unmanned launches there would be no room for mistakes.

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[3] SFRRB members for this meeting were: Walter C. Williams of the Gemini Program Office who headed the meeting; Lester Stewart who recorded the events; Charles W. Mathews, Program Manager; F. John Bailey Jr., MSC Reliability and Flight Safety; Christopher C. Kraft, MSC Flight Operations; Donald K 'Deke' Slayton, MSC Flight Crew Operations; and G. Merritt Preston, Florida Operations.

A catastrophic failure or an aborted mission would put added strain not only on the rest of the Gemini series, but also on Apollo's already-tight schedule to send men to the surface of the moon within the next 68 months.[4]

The final hours in the countdown for the first Gemini picked up right on schedule at 06:00 EST, under a beautiful Floridian sky with a few low, puffy clouds topped by high, thin, transparent clouds. The temperature was recorded at 80 degrees F (26.6 degrees C), with wind speeds of 12–16 knots (13.81–18.41 mph or 22.22–29.63 kph). Circling the pad were a number of aircraft which were intended to observe the launch, but would remain at a safe distance in case of a serious malfunction. The vehicle erector was lowered just 35 minutes prior to launch, leaving the Titan standing alone on its launch pad. In total, the launch operations for Gemini 1 involved a 390-minute countdown that included a scheduled 23.5-hour hold at the T–330-minute mark.


[Left] GEMINI FLIES! April 8, 1964. The first Gemini-Titan combination leaves the launch pad to begin the Gemini flight operations phase.[Right] Group 2 astronauts John Young (left) and James McDivitt, both yet to be formally assigned to a mission, monitor the activity at Launch Pad 19 from the Pad blockhouse during preparations to launch Gemini 1. (Image courtesy Ed Hengeveld)

[4] It has been a long-held misconception that when President John F. Kennedy challenged Apollo to reach the Moon by the end of the decade, he meant by December 31, 1969. In fact, the end of the 'sixties' decade was on December 31, 1970, but it is more widely accepted now to refer to the last year of a decade as the one that ends in '9'. In this case, therefore, "by the end of the decade" is taken to mean December 31, 1969.

The Gemini 1 mission was initiated by the launch vehicle sequencer at T–3.682 seconds, at which point the ‘engine start’ signal was sent to the Titan. Just one second after 11:00 (11:00:01) EST, the sleek, black and white Titan II burst into life, as a cloud of billowing red and orange smoke (the infamous BFRC) emerged from beneath the vehicle. For two seconds, the twin engines built up thrust, but the Titan remained firmly held on the pad until it attained 77 percent of its thrust. Then the pad connections were severed and the vehicle was released.

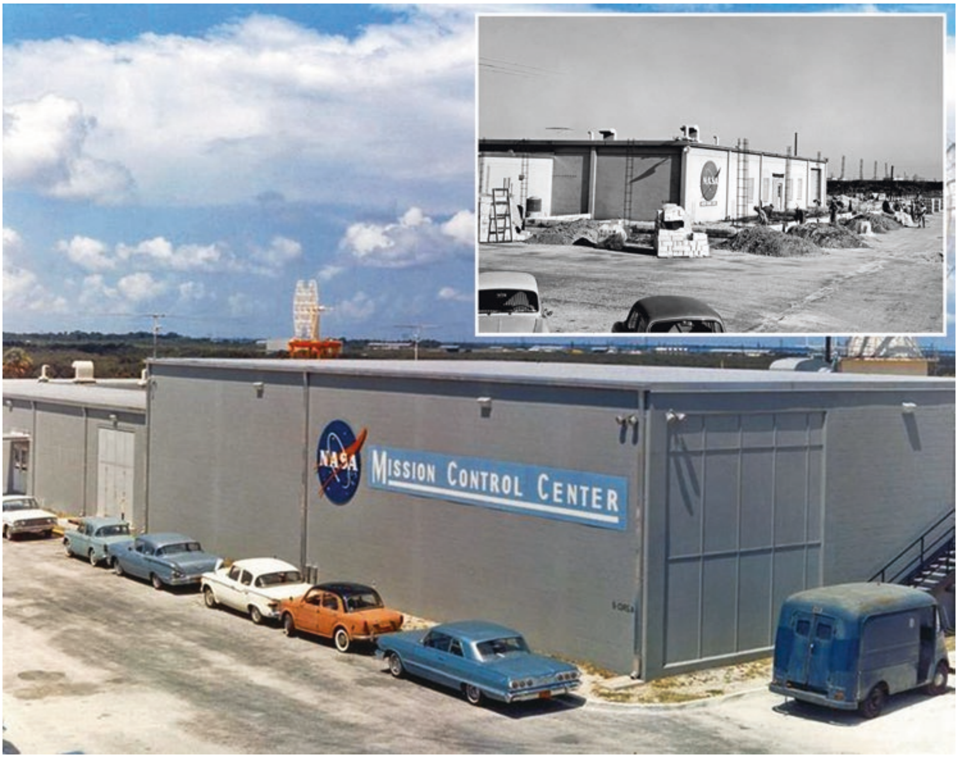
Officially, a Gemini lift-off was deemed to be the point at which the pad disconnects were separated after the vehicle had lifted 1.5 inches off the pad. So, at 11:00:01.69 EST, the first Gemini-Titan combination began its journey from the pad, courtesy of the two first-stage J-7 engines delivering their 430,000 pounds (1912.7 kN) of thrust.

Almost imperceptibly at first, the acceleration gradually increased as the stack rose majestically into the sky. The event was not only recorded by NASA’s official cameras but also by about 100 reporters and photographers, there to witness and record the start of a new journey of American human spaceflight first-hand. For onlookers, standing two miles away, the twin engines emitted a rolling type of roar, much louder than that of the Atlas during Mercury launches. Twin flames emitted from the base of the Titan, creating a perfect ‘V’ behind. Gemini was clearly airborne, but not yet in space. Shortly after launch, an official joked that the countdown clock must have been in error. Everything had gone very well with not even a second’s delay, so it must have been the range clock that had been wrong by a second, not the Titan.

The vehicle initiated its roll from GET 12 seconds until GET 23 seconds, to change from the launch stand azimuth (direction) of 85.2 degrees to the flight azimuth of 71.9 degrees. This was triggered by the first pitch down rate of 0.6718 deg./sec that was initiated by the onboard flight control system. A second pitch down of 0.4687 deg./sec followed at 88.1 seconds into the ascent and the third, of 0.2734 deg./sec, at lift-off +118.8 seconds through staging, which was completed at 162.0 seconds into the flight. From then until +168.0 seconds, when the first RGS (Radio Guidance Signal) command was received, the onboard flight control system maintained a zero-pitch rate.

At T + 153.988 seconds, the separation of the first and second stages was initiated. This followed a rapid sequence, starting with the shutdown of the Stage 1 engines, followed by the ignition of the single J-5 second-stage engine while still attached to the now-spent first stage (the process was termed ‘fire-in-the-hole’ due to the flame and smoke billowing sideways from the vehicle) and finally the initiation of the physical separation of the stages, all within 0.7 seconds of the initial command.

In his 2001 biography, Gemini Flight Director Christopher C. ‘Chris’ Kraft Jr. recalled his surprise during the separation of the two stages: “The launch was just what we expected until the Titan’s second stage fired. Then, inexplicably, we lost all contact with the rocket and the spacecraft. My reaction was echoed throughout mission control: ‘What the hell…?’ Then, three seconds [later], everything was back. We scratched our heads, made some notes, and went on with the mission.” [14] Kraft explained that the three-second loss of communication was due to the creation of a momentary sheath of charged ions around the rocket as the second-stage engine ignited and the stages separated. Until the rocket stage punched clear of the sheath, all radio signals were blocked, as they are during a spacecraft re-entry. The event was recorded on every subsequent Gemini launch. However, Kraft recalled that they had been fortunate to see the previously unknown phenomenon early in this first mission: “If we hadn’t seen it early, we might have felt that momentary surge of terror that came whenever an astronaut was involved.”



The completed and operational Gemini Mission Control, Cape Canaveral. No longer operationally required, it was closed on June 1, 1967 and became a stop on public tours for the next 30 years. In 1999, much of the equipment, fixtures and adornments in the Flight Control Area was moved to the KSC Visitor Center as an exhibit there. The building itself was demolished in 2010. (Credit NASA KSC). [Inset] Pan American World Airways Inc., was contracted to design an extension to the east, north and the majority of the west and south sides of the original Mercury Mission Control facility at the Cape in 1962. This view shows the foundations for the outer wall extension being laid. (Credit: NASA KSC).

At four minutes and 30 seconds (T+270 seconds) into the mission, Public Affairs Officer (PAO) Paul P. Haney announced to the world that “Everything looks good, couldn’t be better,” with Gemini looking “clean and green.” At six minutes into the mission, confirmation came that the vehicle was in orbit, with Haney adding “This mission could not look greener.”

Gemini Mission Control, Cape Kennedy on April 8, 1964, during the mission of Gemini 1. Front Row from left: Ted White (Philco tech rep at the strip recorder), Arnie Aldrich (in plaid shirt) also at a strip recorder, Flight Surgeon Dr. Owens Coons, Dr. Chuck Berry, Capcom Tom Stafford (red shirt), two unidentified systems controllers. Middle row from left, Manfred 'Dutch' von Ehrenfried, (blue suit), Gene Kranz (black waist coat), John Hodge (white shirt) Chris Kraft (standing), Air Force Captain Pete Clements, two unidentified controllers. Back row PAO Paul Haney. At the far wall plot boards, from left, unidentified (red shirt), Jerry Bostick, John Llewellyn, Tec Roberts, Carl Huss, and an unidentified controller. (Courtesy Manfred 'Dutch' von Ehrenfried)

Despite a slight delay in procedures, the Titan had indeed performed as designed, the pogo oscillation had been reduced by 90 percent and the second stage worked perfectly. The command – and a backup signal – to shut down the second stage had been issued at T+339.194 seconds and telemetry recorded that this signal was initiated at T+339.23 seconds, followed by the physical shutdown of the engine a fraction of a second later. It was noted in the post-flight report that the command to shut down the second stage was 3.73 seconds later than the predicted time, which probably contributed to the gain in velocity in excess of that planned.

Just 360 seconds after leaving the pad, the Gemini 1-Titan combination was confirmed to be in an elliptical orbit of 204 statute miles (328.23 km) apogee, 99.6 statute miles (160.25 km) perigee, with an orbital period of 89.27 minutes. This was about 14 mph

(22.52 kph) faster than planned, resulting in an orbital velocity of 17,534 mph (28,212 kph) instead of the planned 17,520 mph (28,189 kph). As a result of this, Gemini 1 and its attached stage was in orbit 21 miles higher than had been planned. The combination was given the officially recognized international orbital designation of 1964-18A, noting that it had been the eighteenth major object to enter Earth orbit that year.[5] After analysis of the orbital data, the prediction for the orbital lifetime of this first Gemini craft was quoted as 3.5 days, plus or minus a day.

Speaking to the press after the launch, Walter C. 'Walt' Williams, who had previously directed all six manned flights in the Mercury program, confirmed that all onboard systems were functioning very well and within manned tolerances. As for the higher orbit, Williams confirmed that this was still well within the planned tolerances for the manned flights, where such an orbit would easily be corrected by the crew onboard using the Gemini orbital maneuvering system. Watching the launch was William B. Bergen, President of the Martin Company which manufactured the Titan vehicle, who later commented: "As an engineer, this was remarkable to see. Not one hold, it all went so well." Clearly, he was very relieved that it had, as were NASA and the USAF. Williams added that this launch "marks a milestone in the Gemini program and illustrated again the importance of America's space team, NASA, the air force and industry."

With this launch completed, Walt Williams stepped down from NASA to take a position with the Aerospace Corporation. After five months in the post and having served with NASA and its predecessor NACA for 24 years, Williams had resigned his position as Deputy Associate Administrator for Manned Spaceflight Operations on March 12, with plans to leave the agency after the launch of Gemini 1. He would become Vice President and General Manager of Manned Spaceflight for Aerospace Corporation, in El Segundo, California.

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[5] Begun in 1963, the International Designation is the official *orbital* object designation awarded by the international Committee on Space Research (COSPAR) to all spacecraft, satellites, rocket stages, deployed objects and fragments. It is based upon the numerical sequence within a given calendar year (January 1 through December 31). The letter code normally refers to the main instrumented payload (A), the rocket stage (B) and fragments or ejections (C, D, E etc.). Letters I and O are not used and if there are more than 24 elements, the sequence for identifying fragments after Z runs through AA to AZ, then BA to BZ and so on. Before this, in the years 1957-1962, the system utilized the 24 characters of the Greek alphabet, but as more objects began to be launched and debris from them increased, the new system was developed and adopted by the North American Aerospace Defense Command (NORAD) which supplies orbital elements for each object *successfully* reaching Earth orbit. In this system, Gemini 1 received an orbital designation, as did all subsequent Gemini missions and their successful Agena target vehicles, but the sub-orbital Gemini 2 did not, for either of its two flights.

Table 2.2 Gemini 1 Systems - Nominal and Actual Events

Gemini-Titan 1 Systems nominal and actual events (seconds) April 8, 1964		
Events	**Nominal**	**Actual**
Stage I engine signal	-3.2 sec	-3.7 sec
Lift-off	0	0
Roll program begins	9.9	10.0
Roll program ends	20.5	21.0
Pitch rate no. 1 starts	23.0	22.0
Pitch rate no. 1 ends and Pitch Rate no. 2 starts	88.3	87.5
Arm first stage shutdown	144.6	145.0
Stage I shutdown	154.4	154.0
Stage II ignition	155.1	155.0
Staging	155.2	156.0
Initial guidance	167.5	167.5
Stage II shutdown	337.4	339.4
Data courtesy: GT-1 Post-Launch Report No. 1		
Gemini 1 Nominal and actual orbital parameters April 8, 1964		
Parameter	**Nominal**	**Actual**
Perigee	87.5 n. mi	86.6 n. mi
Apogee	161.0 n. mi	172.9 n. mi
Period	89.08 min	89.25 min
Inclination	32.54 degrees	32.59 degrees
Data courtesy: GT-1 Post-Launch Report No. 1		

A short mission

With the primary objective of confirming the structural integrity of the spacecraft and its compatibility with the Titan launch vehicle achieved, the mission of Gemini 1 continued. The launch had provided useful information on the heating conditions on both Gemini and Titan during the boost phase, the performance of the Titan while carrying the Gemini payload, the behavior of the first production-quality vehicle, the onboard launch vehicle circuitry, the Titan's capability of accurately placing the Gemini in its prescribed orbit and the monitoring of the Malfunction Detection System (MDS).

The launch and the environment in which the first Gemini would fly had been deliberately planned to duplicate that of later manned missions, to provide accurate data to establish a baseline for those missions. For Gemini 1, both the second stage and the spacecraft would enter an elliptical orbit with a perigee of 87 nautical miles (100.11 miles/161.12 km) and an apogee of 161 nautical miles (185.27 miles/298.17 km). The launch azimuth was chosen at 72.0 degrees to provide an optimum orbital ground track over the global radar and telemetry stations that made up the Manned Space Flight Network (MSFN).[6] These stations were designed to acquire telemetry data and provide tracking information to determine the particulars of the spacecraft's orbit and to verify various onboard systems. On manned missions, they were also capable of relaying communications to Mission Control, increasing the length of time the ground could remain in contact with the crew.

[6] The MSFN stations used during Gemini 1 were: Kennedy; Grand Bahama Island; San Salvador, Bermuda; Woomera, Australia; Hawaii; Point Arguello, California; White Sands, New Mexico; and Eglin Air Force Base, Florida.

From radar data obtained on the first orbit, the lifetime of the Gemini 1-Titan second stage combination was estimated to be at least 60 orbits (5,356.2 minutes, or 89.27 hours, or 3.719 days) with re-entry occurring on or around April 12.

Radar data received on the second pass indicated that the combination was tumbling at a rate of 2 rpm, which had been expected. [15] Also during the second orbit, tracking radar units recorded two small objects near to the main vehicle. These were small in size and mass and re-entered sometime between the fifth and seventh orbits. They were thought to be small items of debris associated with the vehicle entering orbit.

The official orbital phase of the mission was planned to last only three orbits, or 4 hours 50 minutes after launch, or until the vehicle made its third pass over the launch site in Florida. From that point until its re-entry four days later, however, the combination was tracked for 64 orbits, although the mission officially concluded at 16:00 EST on Wednesday April 8, 1964. All systems performed nominally during the planned mission and operated well within design tolerance. As a result, the mission was deemed a success, with useful data being recorded from the network of instruments and sensors aboard until the onboard batteries expired the following day.

The 31 ft. (9.44 m) Gemini 1-Titan second stage combination (11 ft.-long (3.35 m) spacecraft and 20 ft.-long (6.09 m) cylindrical stage) remained in orbit until April 12.[7] It finally re-entered Earth's atmosphere and disintegrated over the south Atlantic Ocean, mid-way between South America and Africa. [16]

Review of results

On April 15, in its first Post-Launch Report, NASA announced that all the primary and secondary mission objectives had been achieved during Gemini 1. [17]

Good weather at the launch site had allowed both long-range and airborne camera coverage of the ascent, with visibility stated at 10 miles (16.09 km) and cloud cover at 2,000 feet (609.60 m). One of the modifications made to the second stage of Titan II was the inclusion of a radio guidance instrument to provide accurate information to the ground. This was initiated at lift-off +167.5 seconds and operated successfully through orbital insertion. Following the official termination of the mission after three orbits, the combination was tracked by elements of the NASA Manned Space Flight Network, the USAF SPADATS (SPAce Detection And Tracking System) and the Smithsonian Astrophysical Observatory headquarters in Cambridge, Massachusetts.

In its post-flight reports, NASA stated that all telemetry data collected were of an excellent quality and that the onboard spacecraft battery, the three telemetry transmitters, the C-band transmitter and the cabin pressure relief valve had all functioned normally during the flight. Temperature variations were detected across the spacecraft. In the nose of the Gemini, the temperature was recorded some 30–50 percent *lower* than predicted and while some areas were as predicted at the rear of the Conical Section of the spacecraft, other localized points reached 25 percent *higher* than pre-flight predictions. Temperatures in the Adapter Section were slightly *lower* than predicted. A steady pressure was maintained inside the pressurized crew compartment, while the cabin pressure release valve had reduced the ambient lift-off pressure to its design level of 5.5 psi (0.37 bar) as planned. There had been no unusual vibrations or accelerations recorded in the data from the spacecraft.

[7] April 12, 1964 also happened to be the fourth Cosmonautics Day in the USSR.

THE FIRST GEMINI TWINS

Though it may have been more advantageous to have a crew aboard, as Richard Gordon alluded to, the success of the short Gemini 1 mission was an important step towards the goal of placing two-man crews in orbit within a year. Gemini Program Manager Charles W. Mathews stated that Gemini 1 had given the whole team confidence to proceed towards the planned second unmanned flight, a ballistic trajectory, in late August or early September and possibly a manned orbital flight by the end of the year.

On April 13, 1964, five days after Gemini 1 flew and just a day after it had re-entered the atmosphere, Dr. Robert R. Gilruth, Director of the Manned Spacecraft Center, named the crews for the first manned flight, Gemini 3, as a way of highlighting that goal. Virgil I. 'Gus' Grissom was named as Command Pilot and John W. Young as Pilot, together with Walter M. 'Wally' Schirra as the backup Command Pilot and Thomas P. 'Tom' Stafford as the backup Pilot. A question and answer period followed, in which Grissom was asked by a reporter what he thought was the "hairiest part" of the upcoming flight, to which the dead-pan astronaut replied: "The part between the lift-off and the landing." [18]

April 13, 1965. During a press conference held in the Building 1 auditorium at MSC, Houston, the prime and back up crews are named for the first manned mission, Gemini 3. (From left) Paul Haney, MSC PAO (standing); Walter Schirra, BUp Command Pilot; Thomas Stafford, BUp Pilot; Dr. Robert Gilruth, Director MSC; Virgil Grissom, prime Command Pilot; John Young, prime Pilot; and Deke Slayton, Assistant Director, Flight Crew Operations at MSC.

Gemini to the Moon?

The success of Gemini 1 certainly spurred the team on and hopes were high for a possible manned flight by the end of the year. But it was not as simple as that. The Titan may have been cleared for use in the Gemini program, but the spacecraft had yet to be tested in re-entry and recovery from space, which was the task for the planned sub-orbital mission of Gemini 2. In spite of the success of Gemini 1 and progress on various spacecraft systems and areas that had been causing delays and doubts for some time, such as the land-landing capability, there remained very real challenges in qualifying the target vehicle planned for later missions and in securing the funding for the whole program. But in light of recent developments, it was a positive start to the Gemini story.

The tide of success was such that there were renewed suggestions that Gemini might even be flown on a lunar mission. Originally, there had been plans to fly Apollo missions on the Saturn 1 vehicle, but those were cancelled shortly prior to the flight of Gemini 1. With manned Apollo missions on the uprated Saturn 1B not planned before 1967, Gemini would be required to fill the gap between Mercury and Apollo. NASA's Associate Administrator for Manned Space Flight, George E. Mueller, even asked if Gemini could fly a lunar flight around the Moon if Apollo encountered any serious delays. Studies had already looked into such a plan and these were dusted off and revisited once more, pending a more detailed study by the Gemini and Advanced Manned Mission Program Offices. Down at Marshall Space Flight Center in Alabama, Dr. Wernher M. M. F. von Braun, creator of the Saturn family of launch vehicles intended to launch Apollo to the Moon, thought that such a proposal should only be considered as a salvage plan to save the prestige of the United States if "the manned lunar goal proves impossible," though he was not questioning whether his Saturn rockets would work as advertised. The primary stumbling block to such a detailed and diverse plan, inevitably, was financial. Both the huge investments in the Apollo effort and the lack of funds to start new programs ended any serious studies to send Gemini around the Moon, or indeed anywhere else as it turned out. Such plans would remain confined to paper studies and artistic impressions. [19]

During the rest of the 1960s, NASA would face similar funding issues over its plans to use surplus Apollo hardware to create a small space station, or to extend lunar operations beyond the early landings. Fearful that funding would not be forthcoming for any new-start projects and at a time of increasing expense in the conflict in south east Asia, proposals to extend Apollo operations beyond the Moon remained exactly that; just a proposal and an extension of the main line Apollo, not a replacement or new-start program. These efforts would linger for a while, under the various titles of Apollo Extension, Apollo X, Apollo Applications and finally (in 1970) Skylab (and Apollo-Soyuz). The idea of using a Gemini to support a space station was even less popular and even the plan to fly Gemini as part of the USAF MOL program was encountering difficulties that it would not recover from.

All of this would be addressed in the future. In the late spring of 1964, the focus was very much on first qualifying Gemini for Earth orbit, before even thinking about what would or might follow. As attractive as further Gemini missions might have seemed – and some artistic impressions surfaced in the 1960s, together with numerous studies which suggested the use of Gemini spacecraft far beyond the original program – nothing would come of them. Instead, work continued towards the planned second launch (Gemini 2) in August and the third (Gemini 3) with its two-man crew in November 1964, each with a four-week contingency period should any problems surface in preparing either mission. All eyes now turned to the next Gemini mission. This would also be unmanned, a necessary prerequisite test of the all-important heat-shield prior to placing men inside the capsule.

SUMMARY

So what had the mission of Gemini 1 accomplished? According to the official report on the mission, all the primary and secondary objectives had been met and achieved. From the primary objectives, the mission had demonstrated the successful performance of the Gemini-Titan combination and had successfully flight-qualified a number of subsystems. The structural integrity of both the launch vehicle and the spacecraft had been verified and both vehicles had successfully demonstrated radiated heating. In addition, the performance of the ground guidance systems had led to a correct insertion into orbit, while onboard instrumentation had been able to monitor and evaluate the GLV switch-over circuits. A tremendous amount of data had been received from the flight instrumentation.

For the secondary objectives, operational procedures for the trajectory and cut-off conditions for the GLV had been achieved, while the tracking C-band transponder in the Gemini vehicle had been able to verify the insertion into orbit. The mission had clearly demonstrated the satisfactory performance of the launch and tracking networks and there had been very useful live training for the pre-launch and launch crews, facilities and flight controllers. There had also been very positive reports in the media, boosting confidence in the Gemini team that they were progressing, at last.

The one thing which was not possible from Gemini 1 was a post-flight inspection of the spacecraft after enduring a complete spaceflight. That objective was assigned to Gemini 2, the next mission on the launch pad.

References

1. *Preliminary Project Development Plan for an Advanced Manned Space Program Utilizing the Mark II Two-Man Spacecraft*, STG, August 14, 1961.
2. **On the Shoulders of Titans, A History of Project Gemini**, Barton C. Hacker and James M. Grimwood, NASA SP-4203, 1977, pp. 55-64
3. **Project Gemini: A Chronology**, James M. Grimwood and Barton C. Hacker with Peter J. Vorzimmer, NASA SP-4002, 1969, pp. 87.
4. Reference 3, p. 100
5. Reference 3, p. 101
6. Reference 3, p. 104
7. **Gemini: Steps to the Moon**, David J. Shayler, Springer-Praxis, 2001, pp. 172-173
8. *First Gemini Orbital Flight Scheduled*, NASA News Release, HQ, Washington, Release No. 64-70, April 2, 1964 (written March 30, 1964).
9. Information courtesy Manfred 'Dutch' von Ehrenfried, via email, February 26, 2017

10. *Gemini Launch Vehicle Test Firing Successful*, MSC Space News Roundup, Volume 3, No. 8, February 5, 1964, p. 1 & 2.
11. Courtesy Air Force Space and Missile Museum
12. *The First Flight*, in *A Taste of Success*, Chapter 9, **On the Shoulders of Titans, A History of Project Gemini**, Barton C. Hacker and James M. Grimwood, NASA SP-4203, 1977, pp. 194-197.
13. *April 7 Earliest Date for GT-1 mission,* MSC Space News Roundup, Volume 3, No. 12, April 1, 1964, p. 1
14. **Flight: My Life in Mission Control,** Chris Kraft, 2001, p. 203
15. *Gemini Program Gets Off to a Successful Start*, NASA MSC Roundup Volume 3, No. 13, April 15, 1964, p. 1 & 3.
16. *Gemini Program Mission Report for Gemini-Titan 1*, prepared by the Gemini Mission Evaluation Team, NASA MSC, Houston, Texas, May 1964, MSC-R-G-61-1,
17. *Astronautics & Aeronautics*, 1964, NASA SP-4005, 1965, p. 134
18. *Gemini Flight No. 1 (GT-1) Post-Launch Report No.1., Mission Operations Report*, No. M-913-64-01, April 15, 1964, memo from George E. Muller, Associate Administrator for Manned Spaceflight to James E. Webb, NASA Administrator; *Grissom, Young named as Prime Gemini Crew*. NASA MSC Roundup, April 15, 1964, p. 1 & 3.
19. Reference 2, pp. 200-201.

3

Ramming the atmosphere

"On the basis of first-look information, we foresee no trouble that will hold up the first manned mission."
Charles W. Mathews,
Gemini Program Manager,
GT-2 post-flight comments, January 19, 1965.

Nine months after the first Gemini flight, a second unmanned test flight was flown. This was the suborbital mission to evaluate the re-entry characteristics of the spacecraft, as well as its recovery systems, prior to placing astronauts on board on the next mission. Gemini 2 may have been the shortest flight in the program but it was one of the most important, a necessary step to qualify the whole system for the planned series of ten manned missions. Not only was the often-overlooked flight of Gemini 2 critical to the rest of the Gemini program and plans for Apollo, but the spacecraft would also later become a useful asset to the USAF Manned Orbiting Laboratory (MOL) program, becoming the first spacecraft to be sent on two different unmanned missions, each designed to qualify systems and procedures for manned flight, for both the NASA and U.S. Air Force programs.

PLANS FOR A HOP INTO SPACE

In its December 1964 press kit, NASA announced that it would "launch the unmanned Gemini spacecraft on a suborbital flight and ram it back through the atmosphere at 16,600 mph (10,316.97 kph) to test the spacecraft under maximum re-entry heating conditions. In addition, the spacecraft will carry all Gemini systems required to qualify it and the launch vehicle for two-man orbital flight." [1] As the NASA release pointed out, Gemini 2 was a highly critical mission. Its success would give NASA the confidence to launch the first manned flight early in 1965, but if any major deficiencies were revealed in either the spacecraft or the Titan launch vehicle, there was a real chance of a significant and crippling delay. It would take between four and six months to identify the problem, incorporate the necessary changes and reconfigure another spacecraft – of which there were a

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_3

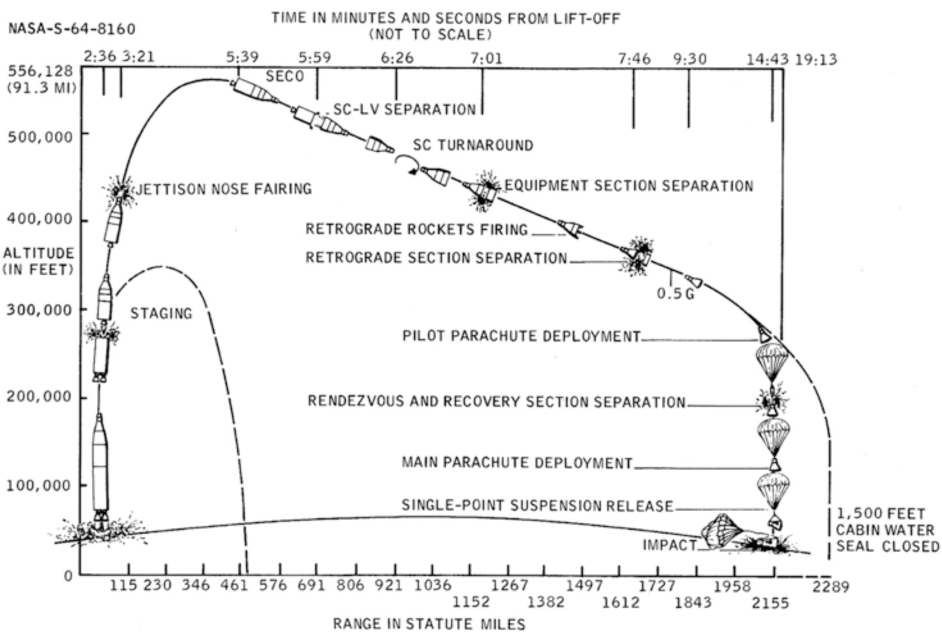
limited number – for yet another unmanned test flight prior to committing a crew to riding aboard Gemini.

Given the nature of its objectives, the plans for Gemini 2 were necessarily quite brief. A minimum of three daylight hours were required for a successful recovery of the spacecraft following splashdown, which meant that there were restrictions to the times at which the vehicle could be launched, set at no earlier than one hour after sunrise and no later than four hours before sunset.

Gemini 2 would be launched from Pad 19 on an azimuth of 105 degrees and, unlike the first Gemini, the spacecraft was to separate from the Titan upon reaching orbit and conduct a turnaround maneuver to achieve the re-entry attitude. Though not actually required on this mission because of the ballistic trajectory, the retro-rockets were to be fired in sequence for 62 seconds. The total flight time was set at no more than 20 minutes, during which the Titan would boost the Gemini to a maximum height (apogee) of about 106 miles (65.88 km). This would result in a separation velocity of about 24,400 ft./sec (80,052.5 m/sec) at an altitude of about 100 miles (160.9 km). The planned splashdown in the Atlantic was expected to be about 2,150 miles (3,633.5 km) down range from Cape Kennedy, approximately 800 miles (1,287 km) east of San Juan and several hundred miles north-east of Trinidad, with the recovery at the end of the mission to be completed by U.S. naval forces.

Test objectives

The flight path was deliberately chosen to place higher than normal levels of re-entry heating on the spacecraft, in order to provide flight data at the extreme design tolerance of the ablative material covering the heat shield. Data from this re-entry would provide evidence for planning the subsequent manned flights, which were to be flown at substantially lower heating rates than planned for Gemini 2.



A diagram of the Gemini 2 mission profile.

The primary objectives set for Gemini 2 had more far-reaching goals than simply a suborbital profile. If successful, Gemini 2 would not only flight-qualify the heat shield but would verify the whole spacecraft and launch vehicle, as an integrated system, as safe for manned flight. There had been significant ground tests and simulations on the heat shield design over the previous three years and NASA had comparable flight evidence from the Mercury missions, but there remained the hurdle to prove unequivocally that the enlarged Gemini design could indeed withstand significant temperatures during entry. The thermal design temperature was listed as 1,725 degrees F (940 degrees C) on the René shingles during a nominal re-entry, but for this mission the temperature would reach 1,740 degrees F (948.88 degrees C) and while the heat shield bond line was designed to withstand 620 degrees F (326.66 degrees C) on a nominal re-entry, for Gemini 2 this would reach 680 degrees F (360 degrees C). The success of this mission rested on the heat shield withstanding these higher temperatures and this was the mandatory objective for Gemini 2 to be classed as a successful mission.[1]

In addition, the structural integrity of the spacecraft had to be demonstrated from the moment of lift-off through to the splashdown and recovery at the end of the mission. The other primary objectives listed by NASA were the satisfactory performance of: the re-entry control, retrograde rocket, parachute recovery, pyrotechnics, communications, electrical, sequential, environmental control and spacecraft displays; the Orbital Attitude and Maneuvering System (OAMS) and associated electronics; the Inertial Measurement Unit (IMU) during both the launch and re-entry; the inertial guidance during the turnaround and retro maneuver; the recovery aids of the spacecraft; and tracking and data transmission. Finally, Gemini 2 would also further evaluate the spacecraft and launch vehicle checkout process and launch procedures, as well as evaluating the backup guidance steering signals through the launch phase and, for the first time during Gemini, the naval recovery forces.

Although it would be a short mission, there were also a number of secondary objectives assigned to Gemini 2. These were not mandatory for the mission to be called a success, but were classed as desirable to enhance knowledge of the performance of the spacecraft and launch vehicle. It was planned to: collect data on the cryogenics and fuel cells; gather additional data on the compatibility of the launch vehicle and spacecraft through the countdown and launch phase, to compare with Gemini 1; further qualify the ground communications and tracking systems planned to support future manned missions; offer further training for launch crews and flight controllers in the preparation and execution of the manned operational missions; and further qualify the Titan II's ability to insert the spacecraft into a prescribed flight path successfully and safely.

To achieve these objectives, a number of systems and sub-systems in the spacecraft and launch vehicle would be monitored by ground controllers and onboard instrumentation. Gemini 2's physical structure and maneuvering retro-rockets were to be put under

[1] This test flight was being closely monitored by the USAF as well as NASA and its contractors, because of the plans to use the Gemini spacecraft as the primary crew return vehicle for their astronauts flying classified Manned Orbiting Laboratory missions.

scrutiny. Its guidance and control systems, including the electronics within the computer attitude control and maneuvering system, the IMU, the single (for Gemini 2 only) horizon scanner, the manual data insertion unit and antenna displacement, were all to be evaluated. Within the spacecraft's electrical system, the sequential, power and crewmember simulators would be evaluated and the all-important Environmental Control System's (ECS) coolant system put to the test.

In addition, the spacecraft's communications equipment, including the UHF and HF voice transmitters and receivers, the digital command system, voice control center, C-band beacon, UHF recovery beacons, telemetry transmitters and the antenna systems electrical timer and events timer, were all programed to gather data for analysis. The data activation system, including the PCM multiplexer encoder, onboard data playback tape recorder, sensors and conditioners, onboard recording sequence data system, display panels and window cameras would also all be evaluated. In the crew compartment, crew water systems (except the drinking water dispenser) to collect fuel cell water, cabin displays and switches were all to be tested. Testing would also cover the landing systems from orbit to splashdown, including the pyrotechnic systems, pilot and main parachutes, the change from one- to two-point suspension, impact with the ocean and Gemini's seaworthiness and recovery.

Finally, the Titan itself would be subjected to a barrage of tests and evaluations for a second time carrying a Gemini spacecraft. Once again, its flight control, guidance, electrics, hydraulics, structures, propulsion, instrumentation, range safety ordinance and the Malfunction Detection System would all be under scrutiny.

In no way could Gemini 2 be termed a 'simple' suborbital flight and with so much resting on its success – and the lack of a suitable replacement vehicle should anything go wrong – the team was under pressure to ensure all would go well first time.

Flight test objectives and system priorities

While the major purpose of the second Gemini mission was the requirement to test the re-entry heat protection applied to the Gemini spacecraft and the flight would be a second opportunity to qualify all of the systems necessary to support future manned flights, there was much more to GT-2 than that. [2]

First Order Objectives:

A. Demonstrate the adequacy of the Re-entry Module heat protection during a maximum heating rate re-entry.
B. Demonstrate the structural integrity and computability of the spacecraft and launch vehicle from launch through spacecraft separation.
C. Demonstrate satisfactory performance of the following spacecraft systems:

    1. Re-entry Control System (RCS).
    2. Retrograde Rocket System (RRS).
    3. Parachute Recovery System (PRS).
    4. Pyrotechnics.

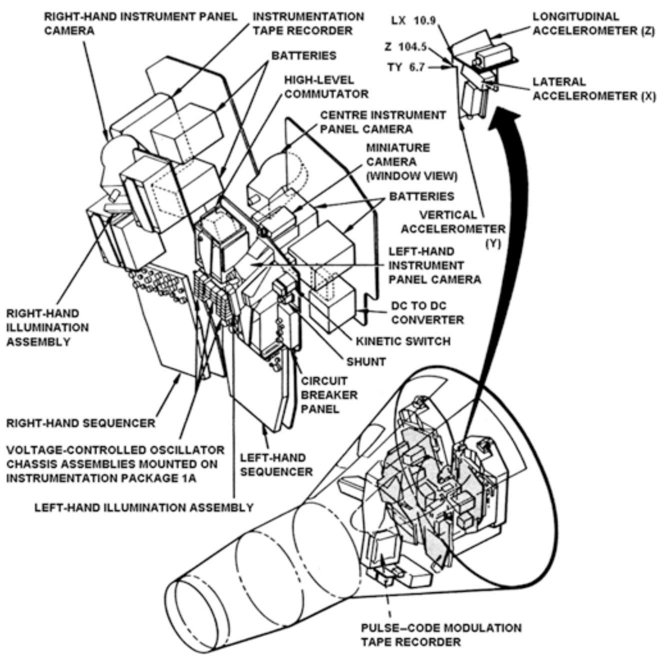
5. Electrical System.
6. Sequential.
7. Spacecraft Displays.
8. Orbital Attitude and Maneuvering System (OAMS) – during the separation from the launch vehicle.
9. Inertial Measurement Unit (IMU) during launch and re-entry.
10. Inertial Guidance System (IGS) during (spacecraft) turnaround and retro-fire.
11. Spacecraft recovery aids.

Second Order Objectives:

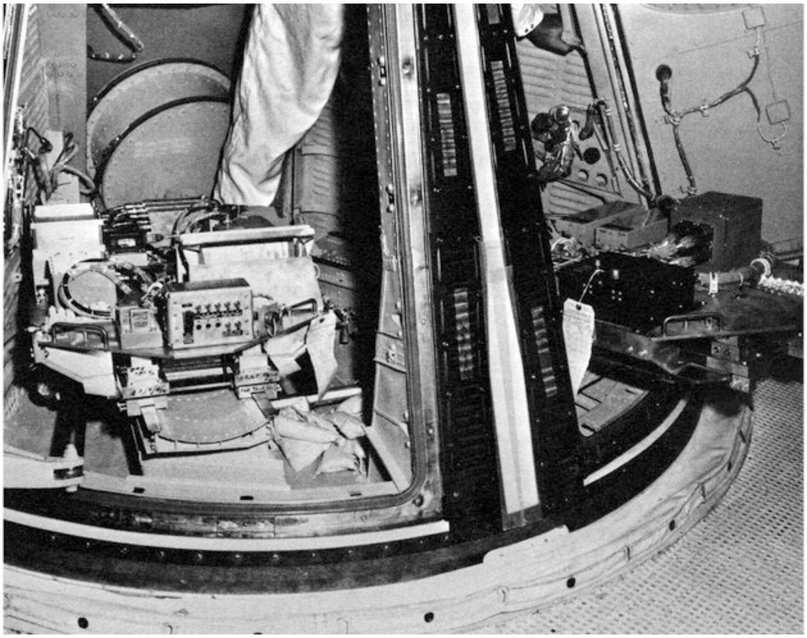
A. Obtain test results on the following systems:

   1. Environmental Control System (ECS).
   2. Cryogenics.
   3. Fuel Cell.

B. Further flight-qualify and demonstrate the ability of the launch vehicle to insert the spacecraft into a prescribed orbit.
C. Demonstrate the compatibility of the launch vehicle and spacecraft through a countdown and launch sequence (including switchover).
D. Provide training for flight controllers.



Astronaut simulator instrument pallet locations for the Gemini 2 mission.



The pallets installed inside the crew compartment of Gemini 2, during prelaunch preparations inside the White Room at Pad 19.

Spacecraft configuration

Gemini 2 was a production-configured vehicle that included all the systems and equipment necessary for launch, retrograde, re-entry and recovery, though without an actual crew and their personal equipment. As no astronauts would be aboard Gemini 2 during its roller-coaster ride to space and back, two crewmember simulators were included in place of the two human payloads. These were designed to complete the sequential functions that the astronauts would be expected to complete on a manned mission, which on this flight included flight signals for launch vehicle-spacecraft separation, the turnaround of the spacecraft, retrofire and retro adapter separation and recovery.

The only components which were not included in the spacecraft were those which had no bearing on the planned suborbital ballistic trajectory and could be qualified by other means or on later flights. The deleted components included the 8.3-ft. (2.53 m) drogue parachute, the rendezvous radar, the docking system, one of the pair of UHF and HF transceivers that would be carried on each manned mission, the food containers and drinking water dispensers, the waste disposal system, the personal hygiene system, the biomedical tape recorder and voice tape recorder, the survival kit, the egress kit and the astronauts' personal equipment.

Apart from the controls and displays associated with later docking missions with the Agena target vehicle, the configuration of the crew compartment of Gemini 2 was identical to that of the manned spacecraft. Each of the two crewmember simulators located in the ejection seats consisted of sequencers, batteries, instrumentation components, cameras and lights, a timer and a tape recorder. The objective of these automated ‘astronauts’ was to perform essential functions that would normally be conducted by the human crew, as well as recording vibrations, temperatures, pressure measurements and variations during launch and entry. There were also four cameras set up in the crew compartment. Three 16-mm black and white motion picture cameras would be used to obtain a visual record of the instrument displays as the flight progressed, while the single 16-mm color motion picture camera was located at the left window to record a command-pilot’s-eye view for 12 minutes following retrofire, though re-entry.

Though the simulators had no metabolic functions, the spacecraft coolant remained operational and was circulated through cold plates on the simulators. A normal oxygen flow was also passed through them to mimic the actions of a ‘real’ crew. The ejection seats were reworked for the mission and though operating elements of the ejection systems were installed, the seats were not armed for ejection. Instead, both were firmly clamped to the seat rails to minimize any vibration damage to the delicate astronaut simulators.

LAUNCH PREPARATIONS

Following the success of Gemini 1, there was optimism that the second flight would be flown on time and would clear the way for the first manned flight by the end of the year. The plan looked good on paper, but in reality, there were significant delays in hardware delivery and testing to qualify components for flight, so the test program for Gemini 2 progressed much slower than had been hoped for. Full details of the preparations for delivering and testing Gemini 2 and its launch vehicle are shown in Table 3.1

So much rested on Gemini 2 launching on time that when the Design Engineering Inspection (DEI) planned for November 1963 was delayed until February 1964, the Manned Spacecraft Center formed its own permanent DEI Board on January 31, 1964, to ensure that each of the spacecraft’s components would do as they were designed and that the whole integrated system would be capable of achieving the assigned objectives for the mission. On February 12, a nine-member MSC DEI board was formed, made up of a Chairman and vice Chairman, members of the Gemini Program Office and representatives from the Engineering & Development, Flight Operations and Flight Crew Operations Directorates (which included astronaut Virgil Grissom, as part of his technical assignment to the program). This two-day meeting at the McDonnell plant also included 50 experts from the Gemini Program Office and prime contractor McDonnell and an additional 50 observers from other MSC offices, NASA Headquarters and the USAF. This team examined the hardware and associated fabrication and test records in detail to determine whether each element met design specifications, or if not, to ensure that the correct paperwork system was in place to rectify the issue. What emerged was a significant list of minor discrepancies, highlighting 22 mandatory changes, four conditional changes and a further ten issues requiring more study. It soon became clear to the team that preparing Gemini 2 meant working on a completely different type of vehicle to that flown on Gemini 1, which was in effect nothing more than an instrumented shell. Gemini 2 was the first flight-qualified spacecraft to go through the whole process from fabrication at McDonnell to

Table 3.1 Gemini 2 Vehicle Manufacturing and Testing History

GEMINI LAUNCH VEHCLE GLV-2	
Event	**Date**
Start major welding of propellant tank of Gemini Launch Vehicle at Denver	1962, September
Delivery of GLV propellant tanks to Baltimore	1963, July 12
Completion of GLV assembly	1964, January 9
Completion of GLV horizontal tests	1964, January 17[1]
GLV Erected in vertical test facility	1964, February 7
Power applied to GLV	1964, February 20
Completion of GLV Subsystems Functional Verification Tests	-
Completion of GLV Combined Systems Acceptance Test	1964, April 22
Inspection of GLV by the Vehicle Acceptance Team	1964, April 27
GLV Department of Defense Form DD-250 – Material Inspection and Receiving Report (MIRR) completed	1964, June 22
GLV delivered to the Eastern Test Range, Florida	1964, July 11
GLV erected at Launch Complex 19	1964, September 14[2]
Power applied to GLV	-
Completion of Subsystem and Combined Systems Tests	1964, October 20
Tanking exercise	-
Spacecraft mated to GLV	1964, November 5
Joint Combined Systems Tests	1964, November 18
Countdown practise exercises completed included Wet Mock Simulated Launch.	1964, November 24
Final Status Simulated Flight Test (SFT)	1965, January 14[3]
LAUNCH	1965, January 19[3]

Notes:
[1]POGO kit installed between January 20 and February 5, 1964
[2]First erected July 16, 1964. Subsystems tests begun on July 17, which were nullified by lightning strike on August 17; Hurricane *Cleo* forced the State II to be disassembled on August 28 and re-erected August 31; Hurricane *Dora* forced vehicle disassembly on September 8
[3]Following SFT on December 3, 1964 the launch was scheduled for December 9, then aborted on that date at ignition plus 1.7 seconds

Data obtained from Aerospace, *Gemini Program Launch Systems Final Report* and Martin, *Gemini-Titan II Air Force Launch Vehicle Press Handbook* as presented in Appendix 3, Table A, Project Gemini, a Chronology NASA SP-4002, 1969, p.277–278

GEMINI SPACE CRAFT – S/C#2	
Event	**Date**
Equipment installation	1964, June 30
Mating of the Re-entry and Adapter Sections	1964, July 7
Systems Assurance Tests	-
Environmental Control System validation	-
Simulated Flight Test	1964, September 16
Altitude Chamber Test	-
Shipped to ETR	1964, September 21
Complex 19/EIIV and G&C	1964, October 18
Mechanical mating of spacecraft with launch vehicle	1964, November 5
Joint Combined Systems Test	1964, November 19
FCMT/ Final Systems Test	-
Wet Mock Simulated Launch Demonstration	1964, November 24
Final Simulated Flight Test	1965, January 14
LAUNCH	1965, January 19

Appendix 3, Table D, *Project Gemini, a Chronology* NASA SP-4002, 1969, p. 281

testing at the Cape and, as a result, it invariably revealed more problems than the earlier vehicle. The outcome was a delay in testing until July, but by then the traditionally volatile Floridian weather would play its own part in keeping Gemini 2 firmly on the ground.

Battling the elements

The two stages of the Titan booster arrived at the Cape during July and work progressed well on preparing the launch vehicle to accept the spacecraft, which was planned for the middle of August. However, minor problems delayed the delivery of the Gemini spacecraft until early September. Undeterred, the Martin ground crew went ahead and prepared the launch vehicle for its final tests pending the arrival of its precious payload.

Then, on August 17, a severe thunderstorm arrived at the Cape and lightning struck the pad as the tests were being completed. The damage incurred by the ground checkout equipment necessitated replacement of some components, a re-validation of the whole complex and retesting of systems before work could progress. Fortunately, a closer inspection after the storm revealed no evidence of damage to the blockhouse, erector or the Titan, but this did not mean there might not be a problem with associated systems in the electronics and electrical equipment. A thorough investigation of the equipment and systems was organized to determine if there had been any such damage. It was estimated that it would require two weeks to check the equipment fully, repair any damage and perform a full retest of the hardware. The delay was disappointing, but as the work was progressing a new problem arose in the form of Hurricane Cleo, which was heading straight for the Cape.

This time, the Martin team was able to remove the second stage of the Titan and place it under cover in a hanger before the storm arrived, but time ran out before the first stage could be removed and it remained firmly lashed down on the pad with the erector lowered as the storm hit. Fortunately, the highest wind levels experienced were well within the limits the booster could withstand, but the need to reassemble the second stage of the launch vehicle naturally meant another delay to launch preparations. The storm hit late in the week and the weather remained unsuitable to continue working until after the weekend. On top of all this, associated preparatory work for a USAF Titan IIIA launch from a nearby pad further delayed work on Pad 19 for safety reasons, until after that vehicle had been launched on September 1. Due to this combination of delays, the slim hope that the first manned flight could be launched by the end 1964 was rapidly diminishing. [3]

Such were the frustrations in getting Gemini 2 off the ground before the first human crew could be launched that NASA gave serious consideration to replacing it with the launch vehicle intended for Gemini 3, moving each Titan up one mission and even scrubbing the Gemini 12 mission from the manifest. Thankfully, before this drastic decision could be taken, the USAF was able to obtain assurances from Martin Marietta Corporation, Aerojet-General Corporation and the Aerospace Corporation that there had been no adverse effects from the lightning strike or the storm, so the Titan launch remained on the manifest. However, things did not get much better over the next few weeks as two more hurricanes, Dora and Ethel, threatened the Cape. Once again, the team was forced to dismantle the launcher, but this time both stages were stored in the hanger until the hurricanes had passed by. This proved to be a wise move and while more time was lost, no further damage was sustained.

On September 21, spacecraft number 2 arrived at the Cape, but by now the delays had forced NASA to abandon all hope of launching a crew into space in 1964. The earliest Gemini 2 could launch would be mid-November, so Gemini 3 would have to follow in late

January 1965. Despite these setbacks, planning for the remaining nine missions remained on course for completion by the end of 1966, but it was clear that it was going to be a challenging 24 months.

A flightless year for the Americans

NASA had hoped to fly at least one Gemini crew in 1964, mainly to provide confidence and breathing space for the remaining nine manned missions planned over the next two years, each with far more demanding tasks. If all the objectives of the Gemini program could be met, it was hoped that Apollo would start flying three-man crews in Earth orbit as early as the end of 1966, certainly by the beginning of 1967. If everything progressed smoothly, that schedule could lead to the first lunar landing attempt by 1969, or perhaps as early as 1968. Once the initial landing had been achieved, plans were in motion to schedule nine more Apollo lunar landings through the early 1970s leading to extended lunar and Earth orbital activities through into the 1980s, but it would all hinge on Gemini getting the job done. History tells us that even though Gemini played its part superbly, it would not work out that way and evidence exists that as early as 1967 there was a severe lack of available hardware, no contracts and little budget to support the grand plans for Apollo, other than on paper. Despite all that Gemini would accomplish, paving the way for the Apollo landings, Skylab and ASTP, it is sobering to recall that the final Apollo spacecraft flew in July 1975, barely 10 years and 4 months after the flight of the first manned Gemini; a decade of intense activity with extreme highs and tragic lows.

While this was in the future, the year 1964 did not bode well for American human spaceflight, as for the first time since 1961 no American astronaut would ride a rocket into space. Ironically, neither were there any X-15 rocket-research aircraft flights that exceeded the 50-mile (or 80.45 km) altitude that the USAF had declared as the border between air and space, or the 62-mile (or 100 km) limit the Fédération Aéronautique International (FAI) had decided upon as the classification for a spaceflight.

Sunrise on Voskhod

While 1964 was a barren year for American astronauts in space, unfortunately for them that was not the case for the Soviets. The slower than hoped for pace at which the Gemini program was progressing – and the reporting of such in the world's headlines – gave the Soviets another opportunity to score a propaganda 'space first', but not without some risk to the crew. On October 12, 1964, the Soviets launched not two, but three cosmonauts into orbit in a 'new' spacecraft called Voskhod (Sunrise). Much of the promotion of Voskhod centered on the crew no longer needing spacesuits and inaugurating a new era of flying in a "shirtsleeve environment." Dubbed the first space crew, the Voskhod cosmonauts consisted of a senior pilot as Commander (Vladimir M. Komarov), plus a scientist (Konstantin P. Feoktistov) and a medical doctor (Boris B. Yegorov). This was expected to be a long flight and western observers were surprised that they flew for just 24 hours, leading to questions about the true abilities of the spacecraft and the purpose of the mission. The Voskhod crew also became the first cosmonauts to land inside their spacecraft.[2] They didn't have much choice.

[2] At the time – and for many years afterwards – it was thought that Yuri Gagarin had landed in his Vostok at the end of his flight. This was a necessity in order to claim the FAI record, which stipulated that a pilot must launch and land in the same vehicle. In fact, Gagarin had parachuted out of the capsule, as had all the subsequent Vostok cosmonauts.

At the time, it was erroneously thought that Voskhod was a larger and more capable vehicle than Vostok and would be set to compete with the plans of Gemini, but this was not the case. In order to beat the Americans and claim the first multi-crew spaceflight (and little else), the Vostok capsule was stripped of its single ejector seat and three seats were installed at 90 degrees, allowing the cosmonauts to squeeze inside. The internal volume was so tight that the crew simply did not have the room to wear any spacesuits and, even more remarkably, they could not eject at the end of the flight, relying at great risk on a hastily included retro-rocket in the parachute lines to slow their rate of descent. Incredibly, so early in the development of human spaceflight, Voskhod also lacked any launch abort systems. Fortunately for the crew, the Soviets' luck held and they got away with it – just. Subsequently, it was learned that the crew could perform little practical work in the very tight confines of the crew compartment and on such a short flight. However, none of this potential for disaster was known to the Gemini team at the time and it appeared that the Soviets were once again forging ahead with a new era of spaceflight while America was struggling to get its own new spacecraft off the launch pad.

The loss of Ted Freeman

[Left] Buzz Aldrin and Ted Freeman after completing a demonstration of the Gemini spacecraft for the press. This photo was taken on October 30, 1964, the day before Freeman's fatal T-38 accident. [Top right] Ted Freeman looks out of the Gemini simulator during an orientation visit to KSC in May 1964. Freeman is in the pilot position while Roger Chaffee occupies the Command Pilot position. [Bottom right] The wreckage of Freeman's T-38 is lifted on to a recovery truck for transport back to Ellington AFB and the investigation into the cause of the tragic accident. (Images courtesy Ed Hengeveld)

On October 18, less than a week after Voskhod flew, the third group of astronauts chosen by NASA celebrated the first anniversary of their selection to the program. Having reported to MSC for NASA duty between January 1 and 15, 1964, this group, known as 'The Fourteen', may have been the latest rookies in the program, but like the second group before them (and the fifth group after them in 1966), they would become the mainstay of American human spaceflight for the next decade. This group began their training program from February 2 and underwent a busy and challenging syllabus of academic, survival and geological training over the next six months, while concurrently continuing their flying proficiency training in the T-38. On July 8, Deke Slayton, Assistant Director for Flight Crew Operations at MSC, announced new technical assignments for the whole astronaut group, concurrent to their basic training and familiarization sessions with Gemini and Apollo hardware. This was a clear step towards their first flight assignments, which pointed towards later Gemini missions.

One of the leading contenders for one of those later pilot seats on Gemini was Captain Theodore C. Freeman, USAF. On October 31, 1964, Freeman was flying a Northrup T-38 *Talon* jet over the Gulf of Mexico, on a regular proficiency flight to maintain the monthly flying hours requirement for a pilot astronaut. Freeman was an experienced aviator, having been an air force pilot for nine years and had accumulated over 3,000 flying hours, of which more than 2,000 were in jet aircraft. On approach to Ellington Field, south of downtown Houston near to the MSC, he was instructed to wave-off his first approach due to other air traffic in the vicinity. Gaining altitude to align his plane for a second attempt, he looped in a large circle around the airfield and descended back to 1800 ft. (548.64 m). Suddenly, a large flock of snow geese flew across his path, blocking his view. At least one of the geese struck the Plexiglas canopy with such force that it shattered into many fragments, which were sucked into the engine intakes. The remains of the unfortunate goose smashed into the unoccupied rear seat of the aircraft before its carcass spun away into the sky. All of this happened in a split second. Freeman probably instinctively reacted to the sudden impact, but with minute fragments of Plexiglas in both engines, they flamed out and eventually ceased. With the power in his aircraft failing rapidly, Freeman tried to bring the T-38 towards the landing strip, but realized that he was heading for a housing complex on the base and rapidly losing height. He again tried to swing the dying aircraft around away from the houses and though he succeeded, the time it took meant that he was now very low at between 110 and 180 yards (100.6 and 164.6 m) from the ground. As he pulled the ejection handle and blasted out of the aircraft, it nosed downwards at that precise moment. Freeman was ejected forwards horizontally instead of upwards. Tragically, he was too low for a full parachute deployment and he hit the field at high speed just 100 yards (91.4 m) from where the aircraft hit the ground, killing him instantly. Freeman was just 34 years old and became the first loss from the astronaut group. A highly respected and regarded member of the team had been taken so early in such a tragic accident. Aircraft mishaps due to technical failure or pilot error that sometimes resulted in the loss of life were, unfortunately, part and parcel of a career in flying high performance jet aircraft at that time, either military or civilian. It was also generally accepted that training for spaceflight could be as inherently dangerous as flying the mission itself, but to be struck down by a flock of geese on a routine flight was particularly difficult to come to terms with.

Unfortunately, this would not be the last flying mishap to hit the astronaut corps before the Moon was reached. It is of course impossible to say what might have been had he not lost his life so early, but it is generally accepted that Freeman would probably have had a significant career as an astronaut. [4]

EXPANDING THE FLIGHT CONTROL TEAM

As the effort continued at the Cape to prepare the Gemini 2 vehicle for flight, work also continued on upgrading the mission control operations at the Cape from those used in the Mercury Program to support the more advanced Gemini flights, pending the move to the brand new Mission Control being built at the Manned Spacecraft Center (MSC) in Houston.[3] However, the upgraded facilities at the Cape would remain in use for Gemini 3.

As part of the preparations for the first manned Gemini mission, a team of flight controllers travelled from the MSC to the Cape for pre-mission training, developing new operational procedures not only for the upcoming Gemini 2 mission but also for the manned Gemini 3. Their training included simulations of launch, orbital flight and recovery operations using the worldwide tracking network.

Following Gemini 1, there remained eleven flights in the program over two years, planned, ideally, for intervals of less than two months between each mission and with those missions lasting up to fourteen days. A larger team would be required to staff Mission Control round the clock and therefore more Flight Directors would be needed to head up the new teams. In August 1964, two new Flight Directors for Gemini were named. They were Eugene F. ‘Gene’ Kranz (FD #3 White Shift) and Glenn S. Lunney (FD #4 Black Shift), who joined John D. Hodge (FD #2 Blue Shift) to create a three-shift operation, instead of the two shifts that Christopher C. ‘Chris’ Kraft Jr. (FD #1 Red Shift) and Hodge (FD #2) had operated during Mercury. For Gemini, Kraft would now serve as Head of the Flight Operations Directorate.

In the August 5, 1964 edition of Space News Roundup, the members of the Mission Control team for Gemini 2 were identified as: [5]

Operations and Procedures:	*Manfred H. von ‘Dutch’ Ehrenfried; Jones W. ‘Joe’ Roach*
Telemetry and Computer:	*Arnold D. Aldrich; James L. Tomberlin*
Digital Command System:	*Stuart ‘Stu’ Davis (Philco)*
Telemetry and Computer:	*Lary Wofford (Philco)*
Booster Systems:	*William E. Platt Jr.*
Retrofire and Digital Command System Procedures:	*John S. Llewellyn; Thomas F. ‘Tom’ Carter and Jerry C. Bostick*

Between the launch of GT-1 and GT-2, the major reconfiguration program for the Operations Control Room was completed, supporting what NASA reported at the time as the “Gemini non-rendezvous missions” of Gemini 2 and 3. [6] Four new consoles were

[3] The new facilities at MSC are explained in the next title in this series, *Gemini 4: An Astronaut Steps into the Void*.

added to the existing fifteen used during Project Mercury, bringing the total to nineteen. These four new positions were:

Booster Systems Engineer.
This console would monitor telemetry from the Titan II launch vehicle during the launch phase and also serve as a backup systems console following insertion of the spacecraft into orbit.

Guidance and Navigation Control System Engineer.
Information from the launch vehicle was displayed at this console, on the vehicle guidance and the performance of the inertial guidance system. Supported by an auxiliary console, this controller would receive computer inputs, which would be registered and then summary data re-transmitted to selected sites. For the early Gemini missions, in a change from the Mercury program where abort action could have been initiated directly from either the Blockhouse on Launch Complex 14 or from the Operations Room in Mercury Mission Control, this controller worked in conjunction with the Booster systems engineer position. These two positions were designed to provide the flight controllers with data on the performance of the booster and to pass informed decisions on whether to proceed or abort the ascent to the Command Pilot riding in the Gemini spacecraft on top of the Titan booster.

Display Coordinator.
During simulated and actual missions, this position generated both displays and communications for technical control of activities for the Support Control Coordinator console.

Public Affairs Officer.
This position provided voice-over commentary during mission events for the purpose of informing the media and general public, explaining and detailing real-time events during the progress of the mission and providing updates to the flight as it progressed.

For the first Gemini missions, the Operations Control Room featured display consoles for:

- The Display Coordinator
- Support Control Coordinator
- Flight Surgeon
- Electrical, Environmental and Communications System Engineer
- Guidance Officer
- Flight Dynamics Officer
- Network Controller
- Flight Director
- Assistant Flight Director
- Operations and Procedures Officer
- Public Affairs Officer
- Operations Director
- DoD Representative
- Assistant DoD Representative
- Retrofire Officer
- Spacecraft Communicator

- Martin Mission Monitor
- Booster Systems Engineer
- Guidance and Navigation Control System Engineer

Four plot boards were used during the Mercury program, but a fifth board was installed for Gemini 2 and 3 to provide data to the Guidance Officer. It also served as a backup for Plot Board 1, used by the Flight Dynamics Officer. This new board displayed guidance data directly from the General Electric/Burroughs-supplied computers. In addition, a propulsion panel was added above Plot Board 4. This new unit displayed propulsion parameters for both the Guidance and Flight Dynamics Officers from computer data generated by Goddard and Burroughs computers.

A 25 × 8 ft. (7.62 × 2.43 m) Mercury Tracking Network display map was prominent in Mission Control during that program and this was upgraded to reflect the latest station and instrumentation symbols to be used for Gemini. To the left of this, the 8 ft. (2.43 m) square screen used during the Mercury flights was retained, but was reconfigured to project summary data messages to controllers. To the right of the World Map, an 8 × 11.5 ft. (2.43 × 3.50 m) rear projection screen had been used to display trend charts during Mercury. These were now obsolete and were replaced with a variety of data, including flight rules, checklists and time sequences. This was made possible by using a pair of projectors, which were remotely controlled from the Assistant Flight Director's position.

For the first three Gemini missions, including the first manned flight, the Operations Control Room was staffed by personnel from the Manned Spacecraft Center, Goddard Space Flight Center (GSFC) and the Martin Company, as well as from the Department of Defense (DoD). The equipment located in this room was developed, engineered, produced and installed by GSFC staff using guidelines established by MSC. Termed the Goddard Manned Spaceflight Support Office, Cape Kennedy, this group prepared the detailed installation instructions of the consoles and associated hardware, as well as manning the implementation of the hardware. It was also their responsibility to install any modifications that might be required for follow-on missions as the program progressed.

It was hoped that the journey from Houston to the Cape for Gemini 3 would be the final time that controllers would be required to do so for Gemini mission control, as much of the construction and testing of the new Building 30 at MSC was complete. From Gemini 4, it was planned that Mission Control Center-Houston (MCC-H) would become operational as the main control room for American manned spaceflights. For now, however, Mission Control for Gemini 2 and 3 would remain in Florida, under the direction of Chris Kraft and Gene Kranz, while John Hodge would direct a monitoring team in Houston.

UPS AND DOWNS OF GEMINI 2

Work on the booster progressed well as the launch date approached, but qualifying the thrusters of the spacecraft proved troublesome, resulting in a ten-day delay before Gemini 2 made it to the pad, on October 18. There would be a further delay of nine days before the spacecraft pre-mate systems test could be completed. Finally, on November 5, Gemini 2 was physically mated to its launch vehicle. This was followed by a series of tanking exercises, to determine whether the launch crew could load the launch vehicle field tanks efficiently with the equipment they had on the pad. Unfortunately, data revealed discrepancies between what was thought to have been loaded and what was actually in the tank. This error led to the creation of a new series of tanking exercises to address the discrepancies, which lasted throughout the program and were handled by teams affectionately called the "WETS and the TETS." The acronyms stood for the "Wednesday Evening Tanking Society" and the "Thursday Evening Tanking Society." [7]

3… 2… 1… Ignition… Shutdown. A false start

The loading of propellant aboard GLV-2 began just one hour prior to midnight on December 8, 1964 and was completed four hours later. The final countdown would begin one hour after that. This countdown was delayed for a total of 41 minutes by three small holds, but finally, at 11:41 on December 9, as tensions increased at launch control and around NASA, the twin first-stage engines erupted … then promptly shut down one second later, after receiving a split-second electronic signal from the master operations control. Computers in the MCC had detected that hydraulic pressure had been lost in the primary control system and had automatically switched from primary to secondary guidance and control. Almost immediately, the Flight Controllers went into their well-practiced procedures to power down and make the vehicle safe, before Flight Director Christopher Kraft officially cancelled the flight of Gemini 2 just before noon, at least for this day.

December 9, 1964. The Titan II engines ignite at Pad 19 Cape Kennedy, then promptly shut down again just 1 second later, again forcing a launch delay into the new year. Just over a month later, on January 19, 1965, the unmanned Gemini 2 was successfully launched on a 2,000-mile ballistic trajectory to test all the spacecraft, Titan II and ground systems from prelaunch through recovery. (Courtesy Ed Hengeveld)

In his role as the Operations Director, Christopher Kraft gave this official comment shortly after the shutdown: "Although today's events resulted in a delay, they will undoubtedly prove helpful in qualification of the booster and spacecraft's systems for manned Gemini flights." [8] Almost forty years later, in his 2001 biography, Chris Kraft explained the abort from his position in the Control Center in a more personal way. As the Titan ignited and promptly shut down, Kraft was watching his TV monitor and he recalled observing that "a cloud of red, acrid smoke from the propellants obscured the rocket momentarily." Even though his monitor was in black and white, he instinctively knew what was happening a few hundred yards away on Pad 19: "*Damn!* I thought. *What next?* We'd fixed every Titan problem we found and now something new had jumped up to bite us." [9] Resigned to the fact that little could be done other than to reschedule the mission for early in the new year, when he finally read the Martin report into the incident, Kraft realized that "the problem was another of those things that happen when we try to be smarter and more efficient than we really are."

Engineers subsequently discovered that a flange on a servo valve had cracked in two places, resulting in a loss of hydraulic pressure on the primary control system. This forced the Malfunction Detection System (MDS) to switch automatically from the primary to the secondary system and shut down the Titan's engines. Normally, the servo valve and its actuator operated with hydraulic fluid below 3,000 psi (207 bar) and controlled the gimballing of the two Titan engines in flight. Fortunately, the shutdown caused only minimal damage. Since the switch over was within the 3.2-second hold down period, it was deemed a shutdown command and, as a result, the Master Operations Control Set (MOCS) initiated a shutdown 1.02 seconds after the engine start command was received. This had at least identified the failure, but not what had caused it.

The unexpected high pressure within the hydraulic line had caused a breach in the aluminum housing of the servo valve, allowing hydraulic fluid to leak. So why had this happened? It appears that over exuberance in the desire to install "improvements" in the vehicle had been the root cause. During development, it had been decided that the walls of the aluminum housing were unnecessarily thick – in some cases twice as thick as they needed to be – and that a thickness of one-third of a centimeter would be more than enough to contain the expected pressure. To compound the error, no impulse tests were completed during the qualification process. It was suggested that the same type of failure had occurred on other Titan launches, even though these were on the stronger missile design rather than the lighter structural shell of the Gemini Launch Vehicle. While it had been assumed that every weight-saving measure was an improvement to the launch capability of the vehicle for Gemini, clearly this was not the case. As a result, the actuators were returned to the contractor, Moog Servo Control Inc., in Aurora, New York, for evaluation and were then sent back to Martin in Baltimore for further tests. The new actuators were not ready for installation until after the Christmas holidays, so the new launch date was set for 09:00 on January 19, 1965.

However, the efficiency of the MDS in saving the Titan had created another problem for the team at the Cape. They now had a ready-for-launch vehicle on the pad with a flight spacecraft on top, but there was no real precedent for dealing with the aftermath of an abandoned launch. True, they had experience from mock launches of the ICBM, which had been part of regular checkouts of the launch vehicle, but this was different. There was a Gemini spacecraft sitting on top of it and the team suddenly realized that they had no procedures for dealing with removing a spacecraft payload if it had not been launched as planned. This task, as the official Gemini history recorded, would require "some hasty improvisation." [10]

Apart from the challenge of de-tanking the propellants from the Titan, one of the hurdles that needed to be overcome was disarming the pyrotechnics from the isolator valves on board the Gemini that prevented propellants from entering the thruster until commanded to fire. If they had exploded while being removed, there could have been tragic consequences. The draining of propellants from the Titan went smoothly, but the removal of the pyrotechnics was much trickier. These units were not designed to be replaceable, so the technicians had to remove the complete unit. This in turn raised another serious issue, namely working out how to prevent highly dangerous chemical propellants leaking out over the workforce. The solution to this was a novel approach, one so radical that it was not totally understood at the time. It eventually evolved freezing the propellant lines. Having worked out a solution which had never previously been attempted, the workforce then had to come up with an actual process to achieve it. They settled on wrapping copper tubing around the propellant lines, packing them in dry ice and then running liquid nitrogen run through the tubing at the same time as spraying the whole area with CO_2. Remarkably, this worked and the assembly units were replaced on the pad over a couple of days.

For Gemini 3 pilots Gus Grissom and John Young, the success of Gemini 2 was very important, not only for its impact on the program as a whole, but on a very personal level, as Grissom later wrote in his book on the Gemini program: "If this flight was successful, it would be the go-ahead for John and me. When your whole life is bound up in a project like this, well, if you are not emotionally keyed up as the countdown moves to zero you must not be entirely human." [11] Both astronauts, together with their backups Wally Schirra and Tom Stafford, were watching the events of December 9 from Mission Control at the Cape. All four were initially "envious" of the black box astronaut simulators inside the Gemini spacecraft. Then they heard the sound of ignition, followed by the news that Gemini 2 had not left the pad. For the astronauts, this was, "like a karate chop behind the ear," as Grissom recalled. "Flight scrubbed! And nobody had to tell us GT-2 would not fly this day."

The frustration that Grissom and his colleagues felt on that December day was clear, as he explained two years later. It was not immediately clear what had gone wrong, how long it would take to discover what the problem was, nor how long the fix would take once the fault had been found. According to Grissom, Gemini 2 seemed to attract more than its share of bad luck.

With the added delays to the program, coupled with the string of Soviet successes since the last astronaut had flown in space, Gemini appeared to be well behind schedule and, at $1.3 billion, was now at twice the original $600 million estimate that it had been expected to cost. The media were quick to take up this issue with any representative of NASA they could find, especially the astronauts, although they did not really get the answer they were seeking. The countdown was ticking, not only for Gemini but also for Apollo if that program was going to achieve its target of reaching the Moon in the next five years. The pressure was on to get Gemini 2 airborne and successfully recovered, allowing NASA to move on to the first manned flight of astronauts since May 1963.

Five astronauts monitor the flight of Gemini 2 from Mission Control at the Cape. From left, Gene Cernan, Wally Schirra, Gordon Cooper, Deke Slayton and Gus Grissom. (Courtesy Ed Hengeveld)

Since then, the Soviets had flown the solo mission of cosmonaut Valeri F. Bykovsky in Vostok 5, barely a month after L. Gordon 'Gordo' Cooper Jr., flew the longest Mercury flight of just one day. Bykovsky's flight did nothing to help American pride because his solo mission lasted for five days.[4] To rub salt into the wound, a second Vostok was launched on his third day in orbit. This in itself was nothing new, as the Soviets had conducted a similar dual flight the year before with Vostok 3 and 4. This time, however, the lone pilot on Vostok 6 was Valentina V. Tereshkova, who became the first woman to fly in space.

[4] Since 1963, solo spaceflights in Earth orbit have been relatively few in number. Over 50 years after Vostok 5 flew, Bykovsky still holds the record of 4 days 23 hours 6 minutes for a solo flight and this is unlikely to be surpassed in the near future. Eight Apollo Command Module pilots completed a period of solo flight, from Apollo 9 in Earth orbit followed by Apollo 10–12 and then 14–17 in lunar orbit, with the record being held by Apollo 16 CMP Ken Mattingly at 81 hours 27 minutes 47 seconds in lunar orbit in April 1972. It would be more than 31 years before the next solo flight, back in Earth orbit, during the first manned Chinese flight completed by Liwei Yang aboard Shenzhou 5 in October 2003. That flight lasted 21 hours 36 minutes.

A comparable American selection process had been considered but had not been pursued. Naturally, Tereshkova's flight made the headlines around the world. Then, in October 1964, the Soviets had scored another space spectacular with the first crewed flight of the Voskhod. However, this apparent advance in the Soviet human space program was shrouded behind propaganda headlines and secrecy, with the truth behind it all not emerging for years. At the time, however, even Grissom was appreciative of the Soviet success: "The Russians were rightfully proud of their big spacecraft's 'shirt-sleeve' environment and its capability for coming down on land." This had been one of the original objectives, now abandoned, for the Gemini program.

By the time of Gemini 2, public interest in the program had already waned. Grissom noted that the press site had normally been packed with onlookers during the Mercury flights, but on that December day "there was plenty of room for the press corps to walk around while they waited," he observed. Clearly the manned launches attracted the majority of the interest, even though unmanned launches were still relatively novel in the mid-1960s.

Grissom also noted the mood in the aftermath of the aborted Gemini 2 mission, imagining the headlines: "Flight scrubbed! Gemini had slipped again. Poor America! Her spacemen had stumbled over their feet one more time. Gemini would probably be still on the pad when the Russians were launching commuters to Mars." His words revealed the disappointment and frustration he and his fellow astronauts, as well as many of the engineers and managers, were feeling, but he remained confident that the failure of Gemini 2 had affected the press more than the Gemini 3 team. The reason was their belief in the system and the hardware. Grissom wrote confidently that despite the fact that Gemini 2 "just sat there and went fizz," an important lesson had been learnt which directly affected Gemini 3 and each of the eight other manned flights planned to follow it. It had taken a mere fifteen milliseconds for the Malfunction Detection System (MDS) on the Titan to identify a problem on the booster and initiate the process to abort the launch. It was a NASA policy never to launch if a secondary back up system became the primary one. The three seconds that the Titan was held on the pad to build up the required thrust to lift the vehicle to orbit was itself a backup, so if a failure occurred within those three seconds, a shutdown became automatic. This was the case for Gemini 2.

Grissom made another important point. If he and Young had been sitting in the Gemini instead of the automated simulators, what would have happened if the MDS had not been in place to detect the error prior to releasing the now faulty Titan? Grissom noted that NASA had been criticized for adding the extra weight of the MDS to the Titan but then, as he observed, "these critics had the refreshing knowledge [that] they wouldn't be up there in the Gemini spacecraft. That helps a whole heap when you're criticizing." As far as he was concerned, while the launch abort was disappointing and frustrating, patience and persistence were necessary components of the journey to achieve a safe and successful outcome. The events of December 9, 1964 were an important step on the road towards making Gemini work successfully and safely. That experience and knowledge lasted far beyond the missions of Gemini, contributing to a greater understanding of the still relatively new process of human spaceflight.

SUCCESS AT LAST

Over the next few weeks following the aborted launch, the spacecraft and Titan were maintained at a flight status level. One positive outcome in the aftermath of the abort was that future Gemini spacecraft would be fitted with a motor-operated shutoff valve, to make further hypergolic draining procedures much easier and safer.

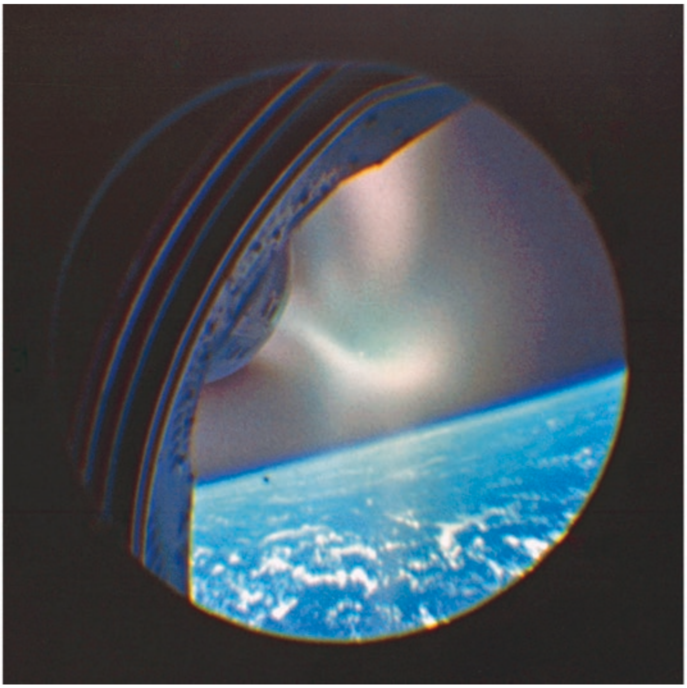
Finally, at 02:00 on the morning of January 19, 1965, the countdown for Gemini 2 began again. It ran remarkably smoothly, apart from a problem with faulty fuel cell stacks. These were an old design that had actually shown signs of problems back in December, but were retained in the hope of avoiding a further delay having to replace them. When these units played up again during the second launch attempt, however, the decision was made to exchange them.

Though they were not sharing live TV this time, the plan was to cover the Gemini launch live, so the press was also inside the control room for the launch of GT-2. A barrage of lights and cameras adorned each side of the control room, with a roving camera attached by an umbilical to a recorder. It made for a scene almost like shooting a movie. In his memoirs, published in 2000, Gene Kranz recalled that as the countdown reached the tense final seconds, all the camera lights came on and the room was "momentarily bathed in brilliant white, while the cameras whirred." He felt the impish urge to cry out the movie cliché: "Lights, Camera, Action!" but managed to resist it. Then, as the launch vehicle left the pad, mission control was plunged into darkness due to the overload caused by the extra camera lighting. Unable to monitor their screens, each controller had to listen to reports coming from the tracking ships and stations down range. Though the team thought they had prepared for every eventually, they had overlooked the possibility of a blackout. [12] The short mission of Gemini 2 was nearly over, with the spacecraft under re-entry, when power was finally restored. A furious Kraft demanded to know what happened. When it was determined that the media lighting was to blame for tripping the circuit breakers, modifications were made to the new MCC at Houston to ensure that something like this would never happen again, with critical systems to be supplied by two separate circuits and powered by three different sources, offering backup and redundancy. The media would have to find its own power. When Hodge joked that Kraft should carry a flashlight at the Cape for Gemini 3, Kraft was apparently not amused.

The official data

Under clear skies and a cool Floridian day, Gemini 2 lifted off successfully at 09:03:59 local time, attaining a maximum altitude of 98.9 miles (160 km) and over 2,100 miles (3,430 km) down range, reaching a speed of 16,708.9 mph (26,991.81 kph) before splashing down in the South Atlantic some 18 minutes later and 25 miles (40.23 km) further north than planned.

The separation of Gemini 2 came after second-stage tail off, imparting a velocity increase of 15 ft./sec (4.57 m/sec). Two seconds after separation from the booster, Gemini 2 was commanded to roll 90 degrees to the left, with a 180-degree turnaround 28 seconds after that. The turnaround maneuver was initiated by the crewman simulators, controlled by the attitude control system and guided by the inertial platform. This was followed by a pitch up maneuver, at separation plus 45 seconds, to a retro attitude of 16 degrees, leaving the small, nose end of the spacecraft pointed down. The Equipment Section was then jettisoned and the automatic retrograde rockets fired at SECO +82 seconds. This was followed by the separation at SECO +127 seconds. The retro fire data was recorded via telemetry, with Retro 1 at T+415.42 seconds, Retro 3 at T+421.41 seconds, then Retro 2 at T+426.20 seconds and finally Retro 4 at T +428.18 seconds.



Automatic camera image out of the crew compartment window of Gemini 2's re-entry. (Courtesy Ed Hengeveld)

The re-entry mode of the Attitude Control Maneuver Electronics (ACME) was programmed for an initial 15 deg./sec spacecraft roll when sensors recorded a load factor of 0.05 *g*, maintaining that rate for 150 seconds. This was followed by GT-2 assuming a maximum lift attitude. The parachute deployment sequence (spacecraft 2 did not carry the drogue chute) was initiated by barostat at an altitude of 10,600 ft. (3,230.8 m), followed by splashdown 1,862 nautical miles (3,448.4 km) down range, based on re-entry tracking data from Antigua.

Tracking for the mission was supported by four telemetry-recording aircraft. The computers at Goddard processed the flight data in real-time and then sent it back for display at Mission Control Center, Cape Canaveral (MCC), with communications supported by NASA Communications (NASCOM). Four telemetry links were maintained throughout the short flight, two for the launch vehicle and two for the spacecraft. Tracking stations Cape Canaveral, Florida (CNV), Grand Turk Island (GTK) and Bermuda (BDA) recorded real-time data from the launch vehicle and spacecraft, sending it to MCC for display to the flight controllers. Tracking ships *Rose Knot Victor* (RKV) and *Coastal Sentry Quebec* (CSQ) displayed spacecraft data to the onboard flight controllers, while MCC, Grand Bahama Island (GBI) and Antigua (ANT), together with the four aircraft, received telemetry for post-flight analyst. [13]

SHIELDING GEMINI FROM THE HEAT

When the Gemini returned from orbit into the dense layers of the atmosphere, the air in front of it was compressed, creating a sheath of super-hot plasma which could vary between 7,232 and 9,032 degrees F (4,000 and 5,000 degrees C). This was more than capable of vaporizing any solid material that it happened to be in contact with and certainly well above the melting point of astronauts. However, rotating the spacecraft to face its blunt end forward into the direction of flight meant that during re-entry a bow wave was formed a few centimeters ahead of the actual structure. This restricted the surface temperatures of the shield to about 2,912 degrees F (1,600 degrees C), controlled not by absorbing the heat but by a process called ablation, defined in the dictionary, in this context, as: "The loss of surface material from a spacecraft or meteorite through evaporation or melting caused by friction with the atmosphere." [14] Essentially, the surface material of the protective shield was designed to char and break away in flaming chunks as the temperatures increased, taking the excess heat away with it. Of course, great care had to be taken in choosing the right type of material, of the correct compound and thickness, to ensure it worked as planned, but it was an effective way of dissipating heat as the spacecraft descended into the atmosphere.

The use of titanium in the load-bearing structure meant that it had to be protected from entry heating, so Gemini's designers applied an outer sheath of high-temperature-resistant material. The pressurized cabin walls were a double layer of 0.010 inch (0.0254 cm) thick titanium, which was reinforced by stiffeners and by the various equipment shelves. The cylindrical Re-entry Control Section was bolted to the Conical Section with nine attachment bolts and the ablation heat shield was attached to a ring at the opposite end of the crew compartment.

The disc-shaped heat shield on Gemini was constructed from a silicone elastomer-filled, phenolic resin-impregnated, fiberglass honeycomb. It had a diameter of 90 inches (228.6 cm) and a spherical radius of 144 inches (365.76 cm) and was attached to the large diameter end of the Re-entry Module with 1.25-inch (3.175 cm) bolts. The structure was assembled in two layers. The innermost layer was 0.75 inches (19 mm) thick, comprising a fiberglass honeycomb covered on both sides with 0.04-inch (1 mm) fiberglass sheeting. On top of this sandwich layer was the fiberglass honeycomb, which was filled with Dow Corning DC-325, a silicone rubber compound. A ring of solid fiberglass (Fiberite MX 2625) and resin was installed around the rim of the shield, where the weight-bearing Re-entry Module would sit on the top ring of the Adapter Module on the launch vehicle. This would serve as an ablator during re-entry.

The DC-325 ablative material was a McDonnell-developed silicon elastomer, subsequently made available commercially by Dow Corning. The shield displayed "excellent ablative characteristics," especially in the char layer that formed during the ablation, its stability under vacuum conditions and its ability to withstand the varying temperatures of the space environment. This concept was a significant design improvement over the shield used during the Mercury program, which had used a phenolic resin-impregnated, laminated fiberglass cloth ablative layer. The weight of the Mercury shield was lighter at 303 lbs. (137.4 kg) compared to Gemini at 317 lbs. (143.7 kg), but because the overall spacecraft was much bigger, the relative increase of the Gemini shield was only 4.5 percent, despite the 48 percent increase in area, a 25 percent increase in ballistic loading and a 90 percent increase in the total heating per square foot due to the critical lifting capability employed by the Gemini spacecraft during entry.

The after-body heat protection used on both spacecraft was almost identical. High-temperature-resistant René 41 shingles were used over the Conical Section, which could withstand temperatures up to 1,800 degrees F. (982 degrees C) by achieving a thermal balance through radiating heat into the atmosphere. These shingles were attached to the structure of the spacecraft by bolts and washers through oversized holes, which allowed for thermal expansion. On support locations, small blocks of Min-K insulation were applied, with Thermo-flex insulation used between the supports to maintain structural temperatures within design limits. Over the cylindrical section of the after-body, where it was impossible to use radiation cooling effectively due to the high heating rates, the heat sink principle was utilized. Beryllium shingles 0.24 inches (6.096 mm) thick were installed on the side of the vehicle facing the direction of flight, while 0.09-inch (2.286 mm) thick beryllium shingles were installed on the leeward side. These also included the provision for thermal expansion.

The heat distribution data gathered on the after-body, based upon earlier wind tunnel testing model data, indicated re-entry at Mach 10 (7,672 mph or 12,346.8 kph) and an angle of attack of 20 degrees. All of the surfaces of the Re-entry Module were coated with black ceramic-based paint, which assisted with the dissipation of heat from the shingles through the process of thermal radiation.

Gemini's center of mass was offset to one side, which meant that one part of the heat shield would endure greater heating levels than the other, so the thickness of the outer layer varied from 0.85 inches (21.6 mm) at the lowest heat load point, to 1 inch (25.4 mm) at the point where the edge of the heat shield endured the highest thermal loading. [15]

The spacecraft was spotted some 25 miles (40.23 km) north of the prime recovery vessel, USS *Lake Champlain* (CG-57), which dispatched an underwater demolition team in helicopters from HS-5 Squadron to attach a floatation collar to the spacecraft to aid the recovery. The same team was also able to retrieve the spacecraft's 330 lb. (149.68 kg)

Rendezvous and Recovery (R&R) Section from the ocean, half a mile to the east of the spacecraft. One of the helicopters returned the ejected parachute container to the carrier, with the parachute bag trailing behind. Chris Kraft stated that the recovery of this section of the spacecraft was a bonus as it was not expected to be recovered, despite being fitted with buoyancy material. Along with the spacecraft, it would be returned for extensive post-flight analysis.

Just one hour and forty minutes after leaving the launch pad, Gemini 2 was recovered at coordinates 16:31.9 North latitude and 49:46.8 West longitude by the carrier USS *Lake Champlain*, which pulled alongside and craned the spacecraft onto a support dolly on the flight deck. [16]

Table 3.2 Gemini 2 Systems – Nominal and Actual Events

Gemini Titan 2 Systems Nominal and actual events (seconds) January 19, 1965		
Events	**Nominal**	**Actual**
Stage 1 engine signal	–3.34	–3.36
Lift-off	0.00	0.00
Roll program begins	4.40	4.34
Roll program ends	20.48	20.40
Pitch rate number 1 starts	23.04	22.99
Pitch rate number 2 starts	88.32	88.07
IGS update received	103.00	103.75
Pitch rate number 3 starts	104.96	104.67
IGS update received	143.00	144.55
Arm first stage shutdown	144.64	144.28
BECO (Stage I shutdown and Stage II engine ignition)	153.52	151.71
Stage separation begins	154.22	152.40
Pitch rate number 3 ends	162.56	162.09
RGS enable	162.56	162.12
First radio guidance command received	169.00	168.29
Jettison spacecraft radar cover, scanner cover and heat shield fairing	198.52	196.74
Stage II engine shutdown circuitry armed	317.44	316.58
SECO Stage II engine shutdown	336.48	335.50
SECO + 20 seconds, spacecraft separates	356.48	352.74
Apogee		85.96 n mi
OHMS burnout		6 m 17 sec
Retro burnout		7 m 23 sec
Blackout begins		14 h 12 m 51 s
Blackout ends		14 h 15 m 21 s
Separation equipment adapter section, initiate automatic retrograde firing sequence	418.48	414.22
Jettison retrograde adapter section	463.50	459.12
0.05 G, initiate roll	567.1	560.23
Initiate full lift	717.1	710.01
Pilot chute deployed	879.2	871.76
Main chute deployed		875.38
Splashdown	1,149	1,096
Data courtesy: MSFN Performance Analysis for the GT-2 mission		

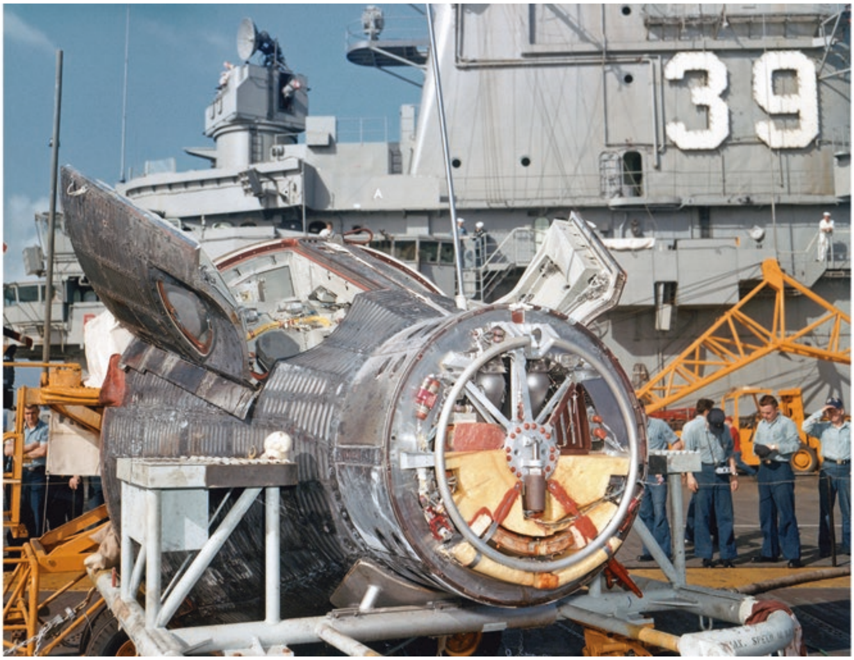
Post-flight examination

The flight was declared a success, with most of the preflight goals successfully achieved. The one exception was a test of the fuel cells, but these had been turned off prior to launch as a result of a failure. One issue reported during the recovery of Spacecraft 2 was of RCS thruster activity from the spacecraft while it was in the water. The initial post-flight examination of the attitude control and electronics package revealed that the AGE had not been adequately waterproofed, allowing salt water to short the system and fire the thrusters. Prior to Gemini 3, the AGE disconnects on subsequent spacecraft were waterproofed, motor-operated shutoff valves were introduced to close both the fuel and oxidizer lines prior to splashdown and the astronauts were instructed to open all the RCS thruster circuit breakers after splashdown. The heat shield of Spacecraft 2 had stood up well to the searing heat of re-entry, which had been the primary objective of the mission (see sidebar: *Shielding Gemini from the Heat*). However, detailed examination revealed that localized heat was evident in one area. Two small holes had burned in the shingles as a result of air flow around one of the umbilical fairings. To reduce the local heating and prevent a reoccurrence, the umbilicals were redesigned, increasing their thickness. The angle of attack was also reduced. Generally, the René shingles successfully acted as a thermal barrier to the heat loads of the spacecraft under the most critical re-entry conditions expected to be endured in the whole Gemini program. The temperatures on the Rendezvous and Recovery Section and RCS Section protected by the beryllium shingles were well below that predicted and designed for but the temperature in the spacecraft's cooling system was found to be higher than planned. The official Mission Report for GT-2 stated: "No problems are expected from the higher total heat inputs which will occur during re-entry for the planned orbits of the Gemini spacecraft. Also below predicted values were the bond line temperatures of the heat shield. Throughout, the shield maintained its structural integrity and the loss of the ablative matter was far less than expected. Therefore, the structure was considered fully qualified for maximum lift re-entry from the planned Gemini orbits." [17]

An inauguration and Apollo

The day after Gemini 2 flew, Lyndon B. Johnson was inaugurated as the 36th President of the United States of America following his success in the 1964 Presidential election.[5] That same day, an article in the *Huntsville Time*s by Richard Lewis suggested that if the pace of Apollo continued at its current rate, then American astronauts could attempt a landing on the Moon as early as 1968. Lewis wrote: "So well does Apollo appear to be running that there is a strong probability that it will overtake the later flights of Project Gemini." [18] Of course, this was before the first manned Gemini had been launched. There was still much work to do in both the Gemini and Apollo programs, as well as the unmanned lunar exploration program.

[5] President Johnson (Democrat) won 61.1 percent of the popular vote on November 3, 1964, beating his rival Barry Goldwater (Republican) who gained just 38.5 percent.



Gemini 2 Re-entry Module on the deck of the recovery carrier. (Courtesy Ed Hengeveld)

SUMMARY

Despite the success of Gemini 2, there were a few minor issues, such as the failure of a voice system component due to the HF voice transmitter failure after splashdown. This was traced to a shorted diode caused by the peak inverse voltage (PIV) supplied as it was turned on, which was in excess of the diode's capacity. All subsequent diodes were installed with a higher peak inverse voltage. NASA remained cautious in planning for future missions. Recommendations from GT-2 included the observation that an analysis of re-entry heating facts should be established. Ideally, this would involve a detailed review of the lift-to drag ratio, including evaluation of the computation equations, angle of attack and temperature boundaries, as well as comparisons of actual flight data from GT-2 to that of wind tunnel data and the collation of ground test data and GT-2 ablation shield data to improve pre-flight predictions. It was also recommended that small changes should be made to increase the margin of safety for re-entry heating, by reducing the angle of attack, increasing the thickness of the shingles in the heat shield and improving the aerodynamic shape of the spacecraft adapter interconnect fittings.

Some of the recommendations from Gemini 2 included the suggestion that the F4C *Phantom* photo aircraft pilots (filming the ascent from the pad) should participate in other launches prior to actual mission imagery runs, to give maximum coverage during the thermodynamic pressure phase of the ascent. It was also acknowledged that additional tracking ship sailing times would have to be added to the nominal sailing times. The *Coastal Sentry Quebec* was supposed to have been on station well in advance of the launch. However, rough seas and "foreign matter" (barnacles and seaweed) had slowed down the ship to the point that it only arrived on station as close as T–4 hours. [19]

Chris Kraft reported that the flight had been very successful and Gemini Program Manager Charles Matthews predicted that the first manned flight would be within the next three months. Gus Grissom and John Young, the two astronauts charged with man-rating the Gemini, expressed their delight at the success of GT-2. Work towards their mission was already well in place, because on January 25, six days after Gemini 2 had left Pad 19, the launcher that was intended to send Gemini 3 into orbit was standing on the same launch pad, minus its spacecraft. After the enforced slowdown of activities caused by the various delays, the pace of the Gemini program was about to be stepped up.

References

1. Gemini 2 Press Kit, December 4, 1964, NASA News Release No. 64-296
2. Information courtesy Manfred 'Dutch' C. von Ehrenfried, via email, February 26, 2017
3. *Cape Kennedy Spared Cleo's Fury; GT-2 Delay May Be Extended,* Space News Roundup, MSC, Volume 3, No. 23, September 2, 1964, p. 1
4. A far more detailed account of the life and loss of Ted Freeman can be found in *A Routine Training Flight* by Colin Burgess in **Fallen Astronauts, Heroes Who Died Reaching for the Moon,** Colin Burgess and Kate Doolan, with Bert Vis, University of Nebraska Press, 2003, pp. 1-31.
5. *MSC Crew at Cape Tests GT-2 Operational Procedures*, Space News Roundup, Volume 3, No. 21, August 5, 1964, p. 2.
6. *MCC at Cape Kennedy Readied for Gemini*, MSC Space News Roundup, Volume 3, No. 22, August 19, 1964, p. 5
7. **On the Shoulders of Titans,** *Chapter 9: A Taste of Success*, NASA SP -4203, 1977, Barton C. Hacker and James M. Grimwood, p. 206.
8. *Titan Shut Down Postpones GT-2 Flight 'Till Early 1965*, Space News Roundup, Volume 4 No. 5, December 23, 1964, p. 2.
9. **Flight: My Life in Mission Control,** Christopher Kraft and James Schefter, 2002 edition, p. 205.
10. *Engineers Explain Cause of GT-2 Abort in December's Unsuccessful Launch Attempt*, MSC Roundup, Volume 4, No. 8, February 3, 1965, p. 5; **On the Shoulders of Titans**, p. 207; also, *GT-2 Launch Attempt Summary, Appendix* B, Section 13, Gemini Program Mission Report, GT-2, February 1965, MSC-G-R-65-1.
11. **Gemini,** Virgil I 'Gus' Grissom, Macmillan, 1968, p. 4
12. **Failure is not an Option,** Gene Kranz, Simon & Schuster, 2000, p. 126
13. *Manned Space Flight Network Performance Analysis For the GT-2 Mission*, Goddard Space Flight Center, Maryland, May 14, 1965, X-552-65-204 (NASA TMX-55227).
14. www.oxforddictionaries.com**, 2017**

15. **NASA Project Gemini Familiarization Manual, Long Range and Modified Configurations,** SEDR 300, Volume 1, McDonnell September 30, 1965; also, *Gemini Design Features*, William J. Blatz, Senior Project Engineer, Gemini, McDonnell Aircraft Corporation, 1963 document, and **NASA Gemini 1965-1966 Owners Workshop Manual**, David Woods and David M. Harland, Haynes Publishing, 2015.
16. Further background information on the naval recovery of Gemini 2 can be found in: *Task Force 140 Makes Test Run: Picking up Gemini*, in **ALL HANDS**, The Bureau of Naval Personnel, Career Publication, April 1965, Number 579, pp. 10-15.
17. *Gemini Program Mission Report GT-2*, February 1965, MSC-G-R-65-1.
18. *Astronautics and Aeronautics*, 1965, pp. 23-24
19. *MSFN Performance Analysis GT-2*, May 14, 1965, p. 48.

4

Preparations

"All astronauts were equal –
just some were more equal than others."
A fabled Astronaut Office 'lore'.

Since the intention was to place astronauts aboard the third mission in the twelve-mission series of Gemini, it was imperative that all of the outstanding developmental issues (and ideally, most of the material ones) were resolved prior to that flight. The missions of Gemini 1 and 2 were critical to ensure the integrity between the spacecraft and the launch vehicle, as well as the capability of the Titan to launch Gemini into orbit. Furthermore, it was crucial that Gemini performed well, not only in the six minutes or so of powered flight but also during orbital flight, to indicate that it was capable of supporting two men for up to two weeks and could withstand the rigors and harsh conditions of orbital flight, the fiery inferno and stresses of re-entry and the ocean landing. Only then would NASA confidently commit to placing two astronauts on a Gemini mission that would finally man-rate the whole system, so that the remaining nine missions could attempt to answer all the important questions the program had been set up for and thus provide Apollo with the necessary experience and confidence to push out towards the Moon.

In preparing for the first manned spaceflight, there had to be a coordinated effort to prepare both the launcher and the spacecraft to ensure they arrived on the launch pad in a state of readiness. For Gemini 3, there was a new element to that process, namely the selection and training of the prime astronauts chosen for the manned test flight. Their training and preparation would set the guidelines for follow-on crews. But who from NASA's elite team of astronauts would get to make that coveted first ride in the new vehicle?

SELECTING THE CREW

By the beginning of 1964, NASA had chosen three groups of astronauts, all pilots by profession, to train for Mercury, Gemini and the early stages of the Apollo program. The first group of seven astronauts, chosen specifically for Project Mercury, was selected in April

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_4

1959 and they were all experienced test pilots with at least 1,500 hours flying time. They became known as the ‘Original Seven’. In September 1962, a further nine test pilots were selected for the Gemini program and potential command seats on the early Apollo missions. By this point, NASA was expecting to fly a significant number of missions during the decade ahead and therefore reasoned that more astronauts were needed, so a further 14 jet pilots (the test pilot requirement had been dropped to broaden the selection field) were brought into the fold in October 1963, mainly to fill Gemini seats and Apollo crew positions. Astronauts from these first three selections would fill all of the available crew positions from 1961 through 1969.

Two other NASA astronaut selections were conducted during the period in which Gemini was operational (1962–1966), aimed at fulfilling Apollo requirements in the early 1970s. This included the first group of six scientist-astronauts who were chosen in June 1965, of whom 5 actually joined the astronaut program.[1] The other group, of 19 pilots, were brought into the program mid-way into the Gemini missions. While they performed some preliminary docking training in Gemini simulators and completed some support work for the program, none of these two groups were given Gemini *mission* training. Instead, they focused on Apollo and its then-planned follow-up program, Apollo Applications.

A dark day in Dallas

The Mercury program had been completed by the fall of 1963 and as development work continued on both Gemini and Apollo, the 16 astronauts selected in 1959 and 1962 occupied themselves in various support roles across those programs. Meanwhile, the members of the newly-selected third group were preparing to immerse themselves in their basic training program. There was optimism for success and of great times ahead, but on November 22, 1963, the hope of a bright future in so many areas suddenly changed.

Two days earlier, on November 20, Donald K. ‘Deke’ Slayton, who was one of the Original Seven but had been medically grounded since July 1962 and had served as the Chief Coordinator of Astronaut Activities since September of that year, had resigned his commission as a major in the Air Force, becoming NASA’s Assistant Director of Flight Crew Operations the following day. [1] With that position came the responsibility of selecting the flight crews, assigning astronauts to various technical duties and overseeing the management of the MSC Flight Crew Support Division, the Astronaut Office and Aircraft Operations. Also that November, Al Shepard, America’s first man in space and another of the Original Seven, was himself formally grounded as a result of an inner ear condition. He was named Chief Astronaut and would work closely with Slayton on the crew assignments of all American manned spaceflights over the next decade.

Then, on November 22, 1963, came the shocking news that John F. Kennedy, the 35th U.S. President and the one who had set America on course for the Moon, had been assassinated in Dallas, Texas. He was just 46 years old. Within two hours of his death, Vice President Lyndon B. Johnson took the oath as the country’s 36th President aboard Air Force One, the Presidential jet. [2]

[1] The sixth scientist astronaut, Dr. Duane Graveline, stood down just two months after selection in August 1965, over personal issues.

Lyndon B. Johnson, onboard Air Force One at Love Field Airport, takes the oath of office as the 36th President of the United States on November 22, 1963, just over two hours after the assassination of President John F. Kennedy. Presiding is Judge Sarah Hughes (lower left, back to camera), while the widowed First Lady, Jackie Kennedy, is standing in the light coat to Johnson's left. Left to Right: Mac Kilduff (bottom left corner), Jack Valenti, Judge Sarah T. Hughes (with back to camera), Congressman Albert Thomas (with bow tie), 'Lady Bird' Johnson, Chief Jesse Curry (with glasses, behind President Johnson's hand), Lyndon B. Johnson, Evelyn Lincoln (partially hidden), Congressman Homer Thornberry (hidden), Roy Kellerman (at rear), Lem Johns (behind Jackie Kennedy), Jacqueline Kennedy, Pamela Tunure (partially hidden), Congressman Jack Brooks, Bill Moyers (with glasses and partially hidden), with two unidentified persons at far right. (Credit: Cecil W. Stoughton, University of Texas archives).

Gene Kranz was in his office in the relatively new Manned Spacecraft Center in Houston when his secretary broke the news of Kennedy's assassination that she had heard over the radio. "The shock spread through the building," Kranz recalled. "We hung on to each radio report… tears were coursing down the faces of Kennedy's moonstruck recruits." Having been galvanized by Kennedy's vision, NASA looked to Vice President Lyndon B. Johnson for leadership, confident that JFK's commitment would be honored. But, as Kranz recalled nearly 40 years after the event in Dallas, it was "an incredibly sad weekend when America came to a stop, stunned by this tragedy. At Mission Control and throughout NASA in our hearts, we resolved to honor John Kennedy's memory by meeting the challenge he had set for us." [3] Project Gemini was the perfect opportunity to begin to fulfill that resolve.

Writing in *Starfall* a decade after the event, Betty Grissom recalled that the family planned to attend the Indiana-Purdue football game on November 22, 1963, although they were monitoring the large, fast-moving cold front coming in. Flying from Houston in Gordon Cooper's Bonanza light aircraft, they had stopped at Little Rock, Arkansas, to refuel and get a weather update. It was there that the news of Kennedy's assassination reached them. Taking a commercial flight on to Indiana, they found that the football game had been cancelled as a mark of respect. "It seemed," she wrote, "that the youthful dream of reaching for the stars, extending man's touch to endless frontiers, might continue… [and that] the astronauts and the thousands of people who supported them might fight even harder to keep the Gemini and Apollo stars from falling." [4]

In the speech Kennedy was due to deliver on that fateful day, he was planning to say (in part) that the U.S. would "[make] it clear to all that the United States of America has no intention of finishing second in space." He would have continued by saying: "This effort is expensive, but it pays its own way for freedom and for America. There is no longer any doubt about the strength and skill of American science, American industry, American education and the American free enterprise system. In short, our national space effort represents a great gain in and a great resource of our national strength…" [5]

Writing in the Washington Star, William Hines predicted that the space program was not expected to change very much under the Presidency of Lyndon Johnson. Firstly, Johnson was as enthusiastic about space as Kennedy had been, perhaps even more so. Secondly Johnson had been involved in the nation's space program from the start, earning the title of 'Mr. Space'. He had helped to establish the Committee on Aeronautical and Space Sciences in the wake of Sputnik 1 and had been responsible for the National Aeronautics and Space Act of 1958 which created NASA from its forerunner NACA. He was also the driving force behind the creation of the Space Council. Perhaps most significantly, he had been instrumental in persuading Kennedy to call for a manned lunar landing before the end of the decade. [6]

Less than a week later, in a TV and radio Thanksgiving address to the nation on November 28, President Johnson said that Station 1 of the Atlantic Missile Range and the NASA launch operations center in Florida would be known thereafter as the John F. Kennedy Space Center and that the name Cape Canaveral was to be changed to Cape Kennedy. [7] The President signed the Executive Order the following day.

ORGANIZING FOR GEMINI

Early in the planning for Gemini, it became clear that at least ten crews would require training to fly the missions. Deke Slayton reasoned that veterans from the early missions would then be available to command later ones or early Apollo missions, including the first attempts at lunar landings. To a degree, Gemini became a valuable indicator of crew performance for subsequent assignment to more complex missions in the future, but with more astronauts available than seats for them to fill, they would not all enjoy the thrill or gain the experience of being a Gemini astronaut, even if they had secured a position on a backup crew. There was also the possibility that some of the 20 Gemini flight seats available could well be filled by experienced astronauts flying for a second time.

Slayton gave an insight into his rationale for Gemini crew selection in his 1994 autobiography, written with Michael Cassutt. Slayton's reasoning for selecting one individual over another to fly a specific mission, or why some astronauts flew together and not with others, remained largely a mystery, even to the astronauts closely involved. His priorities for being shortlisted for Gemini focused upon the program's objectives of long-duration spaceflight, spacewalking and rendezvous and docking. With those skills mastered, there would be a suitably experienced team to form a pool from which crews would be selected for later, more complex missions, both to the Moon and in Earth orbit. Slayton's guidelines can be summarized as follows:

- Everyone was considered qualified and acceptable for any mission when selected for the astronaut program. Slayton's reasoning was simple. If they were hired and they stayed, then they were eligible to fly.
- Given the above, it became clear that some individuals would be more suited to different types of missions, in part due to their previous career backgrounds. These skill sets included management, command roles and those who had held test-pilot roles.
- Pairings were based upon the talents of the individuals and, to a lesser degree, their personal compatibility. To Slayton, merely being selected as an astronaut demonstrated a strong desire, talent and motivation, because those who did not possess such attributes would not have been chosen. Initially, Slayton had assumed that as professional men (mostly military officers), their compatibility would not be an issue, no matter how each was paired. A desire to succeed and to fly a mission was thought to be an overriding factor to overcome any minor personal issues. However, it soon became clear that there would be clashes.
- Slayton was always thinking ahead. Long-term planning remained an important factor in his assignments. In addition, he was aware of future planning trends and training requirements, so it was important to make the best of limited resources and to be flexible in planning as objectives and budgets changed. There also had to be a backup plan in the broader system, where one assignment could affect other plans later on.
- As with any group, of course, 'natural attrition' would have to be taken into account, covering such eventualities as accidents and resignations. Slayton assumed an attrition rate of about ten percent for this and though he considered this to be "a wide guess," he was pretty accurate in his forecast.

In looking at the original objectives for each mission, it became clear that the first four missions (Gemini 3-6) featured unique requirements, while the differences between the final six missions were almost negligible. Slayton realized that it was important to have experienced commanders from the Mercury program in these early missions, who would effectively be mentoring a rookie pilot from the second selection prior to them taking command of one of the later Gemini missions. It was here that Slayton devised his three-mission rotation system, which he continued to the end of Apollo in 1972.

Back up one, skip two, and fly the next

In Slayton's system, a crew which backed up a prime crew on one mission would miss out on the next two missions while they trained to fly the third. Therefore, the backup crew for Gemini 3 would be assigned to fly Gemini 6, the backup of Gemini 4 would fly Gemini 7 and so on. Slayton further realized that once a rookie pilot had flown, he would probably have gained the necessary experience to take a command seat. Therefore, in theory, the Pilot of Gemini 3 could be backup Command Pilot for Gemini 6, matched with a 'rookie' member of the third astronaut group to fly together on Gemini 9. In this system, the final backup flight seats leading to an actual flight on Gemini would be those assigned to Gemini 9 (since the last mission would be Gemini 12). The remaining backup roles on the final three missions would be filled by veterans, or rookie astronauts to gain experience, without the possibility of flying on Gemini prior to possibly moving on to Apollo. In theory this looked like a good plan. However, as Slayton soon found out, even the best laid plans can go awry.

Filling the seats

During 1963, as Mercury wound down, Slayton had begun working out who would fly the first Gemini missions. For the Command Pilots, he naturally looked to his fellow Mercury colleagues, M. Scott Carpenter, L. Gordon 'Gordo' Cooper, John H. Glenn Jr., Virgil I. 'Gus' Grissom, Alan B. 'Al' Shepard and Walter M. 'Wally' Schirra. On paper at least, they were all technically eligible for assignment in Gemini, though this would soon change.

On January 26, 1963, NASA announced new technical assignments for the Mercury astronauts. Cooper and Shepard were responsible for the pilot phases of the remaining project Mercury missions. Cooper was in training for MA-9, with Shepard as his back up and hoping to fly a proposed three-day Mercury 10 mission. Grissom's specialty was in the new Gemini program, while Glenn would focus upon the Apollo program. Carpenter would focus upon supporting the design and development of the Apollo lunar module, while Schirra would be responsible for operations and training for both Gemini and Apollo. Slayton, Coordinator for Astronaut Activities since his grounding from the 1962 MA-7 flight (flown by Carpenter), was to maintain the overall supervision of the astronaut group. In the same announcement, the nine new astronauts chosen the previous September were also given specific assignments: Neil A. Armstrong was to focus upon trainers and simulators; Frank Borman on boosters; Charles 'Pete' Conrad Jr. on cockpit layout and systems integration; James A. 'Jim' Lovell Jr. on recovery systems; James A. 'Jim' McDivitt on guidance and navigation; Elliot M. See Jr. on electrical, sequential and mission planning; Thomas P. 'Tom' Stafford on communications, instrumentation and range integration; Edward H. 'Ed' White II on flight control systems; and John W. Young on environmental control systems, personal and survival equipment. [8]

Grounded himself, Slayton was not eligible for self-selection. Carpenter was considered unacceptable by higher management because of his perceived poor performance during his Mercury flight and was temporarily assigned as Executive Assistant to Robert

Gilruth, Director of MSC. In 1964, an elbow injury as a result of a motorcycle accident in Bermuda removed him from flight status and effectively ruled him out of an early assignment on Gemini. During the spring of 1965, with no chance of a second space flight, Carpenter took a leave of absence to participate in the U.S. Navy's Man-in-the-Sea project, *Sealab.*

Though under consideration, Cooper's future in Gemini was also by no means certain, due to his alienation of some members of NASA's higher management during Mercury. His future beyond Gemini was also in some doubt.

Glenn was hoping for a flight on Gemini. After becoming the first American in orbit the year before, he had been sent out by Robert Gilruth on an extended public relations program, much to his frustration. His character would ensure that he completed the assignment, even though he really wanted to be back in training for a second mission, but he was also hinting that he was considering retiring from the USMC, leaving NASA and pursuing other interests in business and perhaps much later in politics. President Kennedy's assassination made him decide to follow what he saw was his patriotic duty and he entered politics earlier than he had planned, leaving NASA in January 1964 and retiring from the Marine Corps a year later.

With Cooper and Shepard in training for Mercury – and likely to remain active afterwards – and both Grissom and Schirra already assigned to track Gemini, Slayton had these four Mercury veterans in mind as possible commanders of the early Gemini missions.

He also had the nine recently-qualified Group 2 astronauts awaiting their first flight assignments, initially as Pilots, then perhaps as Command Pilots on later flights. Then there was the third group of astronauts, who were currently undergoing selection and who could be considered as another source for Gemini crewing after their basic training, primarily as Pilots, although they would not be ready for assignment to a flight crew for another year. This third group of 14 was chosen in October 1963, but they were not considered for Gemini crewing until probably 1965. From the 30 men available, therefore, there were probably only thirteen names that Slayton could pencil into the crewing roster with any certainty for early Gemini missions. These were: the four Command Pilot candidates from Group 1, Cooper, Grissom, Shepard and Schirra; and the nine Pilot candidates from Group 2, Armstrong, Borman, Conrad, Lovell, McDivitt, See, Stafford, White and Young. From these, Slayton would choose four men (working in pairs) for each mission; two as prime crew and the other two in the backup roles. All the other astronauts, including eventually those from the third selection, would fill in support roles in preparation for their own assignment to a later flight crew.

The early assignments

In mid-1963, the original flight plan for the first manned flight was an 18-orbit/one-day mission. The one astronaut most likely to take the command seat for that prestigious mission was none other than Alan B. Shepard, who had recently served as back up to Gordon Cooper on the final one-day Mercury 9 mission. Shepard had lost the chance to fly what should have been the final Mercury 10 mission, a proposed three-day flight that had been

[Left] Astronauts Al Shepard (left) and Frank Borman (right) pose in front of the Gemini Mission Simulator at Cape Kennedy with Gatha Cottee of the KSC Public Information Office. Shepard was originally scheduled to be the prime Gemini 3 Commander, with Borman as backup Pilot. [Right] Shepard (left) and Borman (right) inside the Gemini Mission Simulator at KSC. (Images courtesy Ed Hengeveld)

cancelled shortly after Cooper landed because NASA was eager to move on to Gemini to gain the experience required for Apollo.

Although he had only flown the 15-minute suborbital flight of Mercury 3, Shepard's experience and training, together with his character and tenacity, made him the most likely candidate for the first Gemini crew. His personality also suited such a high-profile mission and his assignment would provide Slayton with an opportunity to assign one of the new Group 2 astronauts as Pilot.

Looking beyond Gemini 3, Slayton thought that Gemini 4 would be best suited for a strong candidate of the second astronaut group to take an early command. This was a demanding mission, at that time a seven-day extended duration flight, with the potential for a stand-up EVA in the open hatch that would ideally be performed by another strong Group 2 rookie astronaut flying as Pilot. Gemini 5 was scheduled to attempt the first rendezvous and docking flight with an unmanned Agena target vehicle and as such would only be a short flight of one or perhaps two days. For this mission, Slayton had penciled in his fellow Mercury astronaut Wally Schirra, who had already made it clear that he had no desire to fly a really long mission. That long mission, the space marathon of fourteen days, was planned for Gemini 6. Slayton decided that Gus Grissom would be an ideal commander for the long-duration mission, especially as he had worked on Gemini systems since completing his Mercury suborbital flight back in 1961. Yet another rookie Group 2 pilot would take up the Pilot position. That left Gordon Cooper from the Original Seven, who had recently completed the longest Mercury mission. Slayton deftly penciled him into the backup Gemini 6 command position while deciding what to do with him, a choice that included possibly flying a later Gemini mission.

The next task for Slayton was to fill the three or four prime and backup Pilot positions with as many group 2 astronauts as he could, giving them the early experience they needed to allow some, but probably not all, to take a later Gemini command. The rest would probably move on to Apollo. In his deliberations, Slayton sought the views of his Group 1 colleagues and in July 1963, during the regular Monday morning pilot's meeting in the Astronaut Office, he informed the gathered group of astronauts from all three selections of his decisions. For the first manned flight (Gemini 3), he had assigned Alan Shepard as Command Pilot and Tom Stafford as Pilot, with Gus Grissom and Frank Borman as backups. This was an internal Astronaut Office announcement, so nothing was formally released to the press for now. Slayton then told the group that following Gemini 3, Grissom and Borman would rotate to fly the 14-day Gemini 6 mission. In Slayton's opinion, Borman had the tenacity to be able to cope with up to two weeks aboard Gemini on his first spaceflight. The assignments announced at this meeting were therefore:

Mission	Position	Prime	Back up
Gemini 3	Command Pilot	Shepard (Group 1)	Grissom (Group 1)
	Pilot	Stafford (Group 2)	Borman (Group 2)
Gemini 4	Command Pilot	McDivitt (Group 2)	Conrad (Group 2)
	Pilot	White (Group 2)	Lovell (Group 2)
Gemini 5	Command Pilot	Schirra (Group 1)	Armstrong (Group 2)
	Pilot	Young (Group 2)	See (Group 2)
Gemini 6	Command Pilot	Grissom	Shepard or Stafford (or perhaps Cooper)
	Pilot	Borman	Stafford or 1st Group 3 astronaut

It was expected that the backup crews from Gemini 4, 5, and 6 would be assigned to crew Gemini 7, 8 and 9.[2]

Again, this looked great on paper and in principle it worked quite well but, as with most things, changes were soon necessary to reflect both delays to hardware and the program in general and due to the personalities of the astronauts involved. Firstly, it was realized that the Agena docking target would not be ready for Gemini 5 but perhaps for Gemini 6. As a result, the missions for those two flights were simply swapped, with Gemini 5 becoming the 14-day mission and Gemini 6 the first docking flight. Of course, this meant a change to the previous crewing announcement, to allow Schirra and Grissom to switch their previously allocated flight positions. As a result, Schirra and Young were moved to the Gemini 3 backup crew to prepare to fly on Gemini 6, while Grissom and Borman took the Gemini 5 prime crew slot.

Shepard loses Gemini

Over the next six weeks, Shepard, Stafford and their backups trained for the first flight. Then, during a party one day, Shepard quietly informed Stafford that he had a problem with recurring dizziness and was not sure if anything could be done to correct it. This was a potentially serious blow to his future career as an astronaut. In May 1963, it had been confirmed that Shepard was suffering from Meniere's disease, which affected the balance

[2] The full crewing protocol of these missions will be explained in each of these subsequent titles.

system in the inner ear. For a while he could still fly and he retained the unofficial command of Gemini 3, but that position was under threat. By October, it was confirmed that Shepard was being grounded and taken off flight status. He had not only lost the seat on Gemini 3, but probably also the chance of commanding an early Apollo mission. This was devastating news for the astronaut, but he remained determined to return to space one day to add to his short 15-minute suborbital flight and just a tantalizing five minutes of weightlessness. He had the honor of being the first American in space, but not the first to orbit. That had fallen to John Glenn, who had joined Soviet cosmonauts Gagarin and Titov as the first to circle the planet. Shepard had also lost the three-day MA-10 flight because NASA wanted to move on to Gemini and now a medical problem had taken his Gemini seat away from him.

It was not a good time for America's first astronaut, although he was somewhat compensated that November when he was made Chief Astronaut, as Slayton now moved to a higher administrative position. Shepard would serve in this capacity for the next decade. Though he was unable to fly in space himself for most of that time, he would make sure that those who did were the very best NASA had to offer. But deep down, he really wanted

Gemini 3 prime crew in the original David Clark G-2C training suits, with the portable air conditioners connected and wearing their helmets with the visors open. (Courtesy Ed Hengeveld) to take a trip into orbit himself. Well, he really wanted to fly to the Moon and he secretly held out the hope that he could achieve that someday.

Changes to Gemini 3

Tom Stafford reportedly heard about the status of Shepard from one of the NASA doctors rather than from either Shepard himself or Slayton. Though the official crewing was still to be announced, the development naturally meant major changes would be required to the original assignments Slayton had worked out just a few months previously. In addition to crew changes, there were also alterations to the plans for the missions themselves. It had now been decided that Gemini 3 would only fly three orbits not 18, with the intention to increase the mission durations gradually over three flights. As a result, Gemini 4 was cut from seven days to four, Gemini 5 from 14 to seven and Gemini 6 became the first Agena mission. Gemini 7 would now take the marathon 14-day objective.

Slayton chose Gus Grissom to replace Shepard on Gemini 3 and in order to allow Schirra to keep the first Agena docking flight, he was reassigned as Gemini 3 backup Command Pilot. The choice of Grissom was a logical one, thanks to his knowledge of Gemini systems from the earliest days of the program, but there were signs that Grissom and Borman would not work well together. Borman later admitted that he doubted he could have worked with Grissom over the period of several months needed to bring Gemini on line, never mind the original plan for 14 days cooped up in a spacecraft together, so Slayton moved him to the Command seat of Gemini 7 and slotted Stafford in as the new backup pilot of Gemini 3 with a view to assigning him as Pilot on Gemini 6. Slayton felt that Stafford was one of the best of the group on rendezvous issues, which would be of benefit for Gemini 6 and possibly further down the line. Slayton then moved up John Young to fill in the Gemini 3 Pilot seat and to save time and utilize their training, he decided to keep this four-person crew together to move on to Gemini 6 because that was going to be a complicated flight. After Gemini 3, both Grissom and Young would therefore return the favor and backup Schirra and Stafford on Gemini 6, allowing Slayton to move Grissom possibly to an early Apollo crew and give Young a Gemini command of his own.

Five days after Gemini 1 flew, the crewing for Gemini 3 was formally announced by Dr. Robert Gilruth, Director of the new MSC. At last, the astronauts began the formal stages of mission training and as the training for Gemini 3 progressed, so the crews for Gemini 4 and 5 were announced, seeing a total of 12 astronauts (6 prime and 6 back up) immersed in various stages of the mission training syllabus.[3] [9]

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[3] The Gemini 4 crew was officially announced on July 27 as James A. McDivitt, Command Pilot, and Edward H. White II as Pilot, with Frank Borman and James A. Lovell Jr., as their respective backups. This was followed on January 8, 1965 with the announcement of the prime crew for Gemini 5 as L. Gordon Cooper Jr., Command Pilot and Charles 'Pete' Conrad Jr., Pilot, with Neil A. Armstrong and Elliott M. See Jr., as their respective backups. These selections will be described in more detail in the relevant titles in this series.

PREPARING THE HARDWARE

While the four Gemini 3 astronauts became immersed in their training program, work continued on the hardware side of the mission, constructing and testing the spacecraft and launch vehicle and developing the flight plan. [10]

Spacecraft Number 3

The construction of the Gemini 3 spacecraft was completed by McDonnell during December 1963. Then it was moved from the production area to the White Room at the St Louis plant, where the spacecraft's equipment was installed and the latest engineering changes were incorporated into the design. The difficulties with Gemini 2 meant that the intended launch of Gemini 3 would not now occur at the end of 1964, but would slip into 1965.

The first phase of systems testing began in May of 1964 and the initial Development Engineering Inspection (DEI) was conducted over June 9 and 10. This was the first of a series of inspections to ensure that NASA's requirements were being fulfilled by McDonnell. In July, a Gemini Configuration Control Board was established by Gemini Program Manager Charles W. Mathews, so that all future configuration changes could follow a continuous and coordinated path to fulfillment. By the end of the same month, the development of the Gemini 3 spacecraft had been largely completed and it was now time to focus upon production and flight operations.

By September 12, 1964, the equipment had been installed in the spacecraft and the required tests completed. Then, a second major review of the spacecraft, called the Module Test Review (MTR), was conducted prior to mating the separate modules of the Gemini spacecraft together. In this review, 12 teams of engineers, managers and representatives from McDonnell and NASA reviewed the results of the recently completed testing and reported back to the MTR board. The following day, clearance to proceed with the mating was given. It would be another two weeks before this was completed, on September 27, when the Re-entry and Adapter Modules were physically mated for the first time to form the complete Spacecraft Number 3. This was later followed by an altitude chamber test, on November 18, 1964.

A third review was completed on December 3. This one formed the first half of the Spacecraft Acceptance Review (SAR), the final stages of the handover procedure to NASA by McDonnell. Once again, all the test results were scrutinized and only when the acceptance board were happy were McDonnell allowed to continue with the next stage, a simulated flight test that was completed on December 21. Upon completion of this test, the second part of the SAR was held, where a detailed review of that test, plus all the previous tests, the associated documentation and a report on the overall status of Spacecraft 3 was completed. Then, on December 24, the board reported that Spacecraft 3 was acceptable for formal delivery to NASA at Cape Kennedy.

Just four days into the new year, one which would prove to be very busy for the Gemini program, Spacecraft 3 was delivered to Cape Kennedy aboard a C-124 and was taken to the Industrial Area for final preparations. By this, the third delivery of a Gemini spacecraft, it was generally accepted that it was a fully checked out and integrated vehicle. Over the next month, work focused upon closing off outstanding issues from the manufacturing process, as well as installing the ejection seats and various pyrotechnics.

Gemini 3 spacecraft shortly after arrival at the Cryogenic Building at Cape Kennedy, bearing red 'remove before flight' streamers. Also note the temporary protective covering and tape around the crew window and the white covers protecting four of the sixteen oval-shaped RCS thrusters near the top of the spacecraft. (Courtesy Ed Hengeveld)

Just two major tests were conducted at the Cape. As this was the first manned flight, the first of these was a special communications test. Using the Merritt Island launch area radar range, the spacecraft's communications systems were tested in a radio-frequency environment, to duplicate the conditions the spacecraft would encounter during its mission as far as possible. Next came a complete test of the spacecraft's propulsion systems, including a static firing to check out the procedures and the equipment installed and also to provide further confidence in a system which had had its fair share of hurdles to overcome and was still not yet fully qualified. By February 4, 1965, a full month after it had arrived at the Cape, Gemini 3 was relocated to LC-19 to join its launch vehicle.

Modifications to Spacecraft 3

Gemini 3 incorporated a number of significant changes from the unmanned Gemini 2. In the structure of the re-entry assembly, the primary change was in the thickness of the ablative material in the heat shield, which was now in accordance with production design. There were no significant changes in the Adapter Section.

As this Gemini would be carrying a crew, there were a number of upgrades to the communications system. These changes included the installation of a pair of UHF transceivers and a standby telemetry transmitter, which replaced the delayed-time receiver originally planned for Spacecraft 3. In addition, a single lightweight headset was supplied, along with two UHF survival beacons and one voice transmission tape recorder.

The special instrumentation incorporated on Spacecraft 2 in lieu of the astronauts was not required for Spacecraft 3, but the full biomedical instrumentation was installed for the first time. A secondary oxygen high-rate flow rate of 0.08 lbs./min (36.3 grams/min) to each 'crew member' was included in the Environmental Control System, but as this was to be a short flight, the fuel-cell water-collection tank was not installed. A pair of horizon sensors were added to the guidance and control sub-system, while the fuel-cell module on Spacecraft 3 was replaced by a battery module containing three silver-zinc batteries, with the four silver-zinc pallet batteries and two pallet buses deleted. In the propulsion system, the four radial-thrusting TCAs in the OAMS were made inoperative, the burst diaphragms were removed from the OAMS-B package and two motor-operated propellant shut-off valves were installed in the RCS.

Within the crew station, the Government Furnished Equipment (GFE) special instrumentation pallets and crewman simulators were deleted and modifications were made to the flight crew displays and panels. A G-3C spacesuit was provided for each astronaut and stowage provisions had to be made for food, operational equipment, cameras and waste materials. In the landing systems, drogue parachutes were installed and one set of survival equipment (including a life-raft and survival pack) was included for each flight crew member. The pyrotechnics system on the third vehicle included the addition of an ejector designed to release fresh air doors, while the drogue parachute system was fitted with reefing-line cutters, guillotines and a mortar. Pyrotechnics for the ejection system were installed in the lap-belt release, the shoulder strap cutters for each crew member and in the "Jetelox" releases associated with the backboard and egress kit ejection system.

GLV-3

The path to the launch pad for the Titan assigned to Gemini 3 was also a long journey, one that began just a month after the end of the manned Mercury program, back in June 1963, with the welding of the propellant tanks. Assembly continued over the next twelve months, followed by a series of verification tests prior to shipment to the Eastern Test Range. Details of the assembly and preparations for both GLV-3 and the assigned spacecraft can be seen in Table 4.1.

The late delivery of the launch vehicle was due in part to the delays incurred during the preparations for launching Gemini 2. The acceptance for GLV-3 was actually achieved on August 21, but as the Gemini 2 vehicle was still sitting on the pad and there were no suitable storage facilities for additional hardware at the Cape, the new launcher had to remain at the Baltimore facility for the time being. To take advantage of this enforced delay, it was decided to incorporate several engineering changes that had been planned for inclusion when the spacecraft reached the Cape, but could instead now be completed while the vehicle was still in Baltimore.

Table 4.1 Gemini 3 Vehicle Manufacturing and Testing History

GEMINI LAUNCH VEHCLE GLV-3	
Event	**Date**
Start major welding of propellant tank of Gemini Launch Vehicle at Denver	1963, June
Delivery of GLV propellant tanks to Baltimore	1963, December 13
Completion of GLV assembly	1964, June 6
Completion of GLV horizontal tests	1964, June 17
GLV erected in vertical test facility	1964, June 22
Power applied to GLV	-
Completion of GLV Subsystems Functional Verification Tests	1964, July 31[1]
Completion of GLV Combined Systems Acceptance Test	1964, September 30[2]
Inspection of GLV by the Vehicle Acceptance Team	1964, October 7[2]
GLV Department of Defence Form DD-250 – Material Inspection and Receiving Report (MIRR) completed	1964, November 18
GLV delivered to the Eastern Test Range, Florida	1965, January 23[3]
GLV erected at Launch Complex 19	1965, January 25
Power applied to GLV	1965, January 29
Completion of Subsystem and Combined Systems Tests	1965, February 15
Tanking exercise	-
Spacecraft mated to GLV	1965, February 17
Joint Combined Systems Tests	1965, February 24
Countdown practise exercises completed included the Wet Mock Simulated Launch	1965, March 8
Final Status Simulated Flight Test	1965, March 17
LAUNCH	1965, March 23

Notes:

[1]POGO kit installed January 20-February 5, 1964

[2]GLV-3 was not accepted after the first CSAT on August 7, 1964 and the VAT inspection held on August 17, 1964

[3]Modified at Baltimore following the GT-2 tandem actuator trouble at the Cape. The actuator on s/c 3 was replaced on January 8, 1965

Data obtained from Aerospace, *Gemini Program Launch Systems Final Report* and Martin, *Gemini-Titan II Air Force Launch Vehicle Press Handbook* as presented in Appendix 3, Table A, Project Gemini, a Chronology NASA SP-4002, 1969, p. 277-278

GEMINI SPACE CRAFT – S/C#3	
Event	**Date**
Equipment installation	1964, September 12
Mating of the Re-entry and Adapter Sections	1964, September 27
Systems Assurance Tests	-
Environmental Control System validation	-
Simulated Flight Test	1964, December 21
Altitude Chamber Test	1964, November 18
Shipped to ETR	1965, January 4
Complex 19/EIIV and G&C	1965, February 4
Mechanical mating of spacecraft with launch vehicle	1965, February 17
Joint Combined Systems Test	1965, February 24
FCMT/ Final Systems Test	1965, March 3
Wet Mock Simulated Launch Demonstration	1965, March 8
Final Simulated Flight Test	1965, March 18
LAUNCH	1965, March 23

Data obtained from Appendix 3, Table D, Project Gemini, a Chronology NASA SP-4002, 1969, p. 281

The two stages intended for the GLV-3 are being prepared at the Martin Company in Baltimore. In the foreground is the single-engine second stage, with the twin-engine first stage in the background. (Courtesy Ed Hengeveld)

Once these had been implemented and checked, a second acceptance review was conducted on October 9. The Titan was officially handed over to the USAF on October 27, but Gemini 2 remained stubbornly sitting on the pad in Florida, so for a second time it was decided to incorporate more engineering changes to the launch vehicle before it was shipped to the launch site. This work was completed in the middle of January, at last allowing the Titan to be moved to the Cape, but by then another problem had surfaced. Now, the USAF could no longer spare the large C-133B aircraft which had carried the first two launch vehicles. A converted Boeing 377 Stratocruiser, nicknamed the ‘Pregnant Guppy’ because of its bulbous shape, would be used instead, but as it was unable to carry both Titan stages at once the shipment had to be done in two trips. The second stage was flown to the Cape first, on January 21 and then the empty aircraft made the trip back to Baltimore before returning with the first stage two days later.

With all the vehicle elements on hand at the Cape, work now focused on stacking the booster. That process was completed on January 25, followed by the raising of the spacecraft on February 5. The process of checking the spacecraft and its launch vehicle continued over the next month, encountering some minor issues, with Gemini 3 finally physically mated to the Titan on February 17, less than a month after Gemini 2 had left the same pad. With the launch planned for late March, there was ample time to perform the final checks, as well as a simulated flight test on March 18. The positive outcome of these tests cleared the vehicle for launch.

Planning the Gemini 3 Mission

Some references suggest that Gemini 3 had originally been planned as an 18-orbit, one-day mission to evaluate the onboard systems and capability of the new spacecraft and its launch vehicle fully, prior to extending the flight time on later missions which would introduce EVA and rendezvous and docking. This had been suggested in early documentation, but was not formally approved. However, the main objective was clear, even if the duration was not. Gemini 3 had to prove that the new spacecraft could indeed support a two-man crew and therefore verify that it was capable of meeting all the objectives that were being planned for the rest of the missions across the program's compact and intensive lifespan.

The objective was straightforward enough, but the question remained about exactly how long the first mission should be and how to quantify an effective and achievable "determination and evaluation of the spacecraft" on just the third mission of the program and the very first time that astronauts had ridden the vehicle into space. After all, Project Mercury had included a whole series of unmanned pad abort, suborbital and orbital test flights (some with astro-chimps as test subjects) as well as the two manned suborbital flights, before that vehicle was considered ready to support a man in orbit. Even then, Mercury was initially only aloft for three tentative orbits, with the full-day flight reserved as the final objective of that program. For the admittedly far more complicated Apollo program, there was also an extensive and much longer unmanned test and evaluation program under development well before any astronaut would fly it into Earth orbit, let alone to the Moon. So was scheduling Gemini 3 for 18 orbits on the first attempt a mission too far? It seemed so. After a discussion in April 1963, NASA Headquarters chose to support the three-orbit mission option.

Three orbits of Earth with an orbital period of about 90 minutes equated to a flight of about four and a half hours. Taking into account the ascent, spacecraft checkout and acclimatization by the crew that would take up most of the first orbit, the maneuvering during the second orbit and the preparations for entry and the landing sequence on the final orbit, there would be very little time left for the crew to do much testing or experimentation.

Time for Science?

One of the earliest stated objectives for Gemini was to investigate extended-duration spaceflight of up to 14 days. This would provide experience of supporting a crew in space and monitoring their working capabilities in advance of the more challenging Apollo missions. It was reasoned that preparing for and executing the rendezvous and docking and the EVA objectives would inevitably be time consuming and therefore warranted those objectives being assigned to later flights. This would leave the longer duration missions free to concentrate perhaps on a suite of experiments that the crew could conduct, on themselves and their environment or in observations of the Earth and the stellar background. Ironically, little thought had been given to what else the crew might do other than a spacewalk and an Agena docking until the summer of 1963, after the Mercury program had been completed. With the prospect of ten Gemini missions and possibly double that for manned Apollo flights, use of the opportunities available to conduct in-flight experiments in addition to the stated mission objectives began to gain support. However, the idea of overloading the mission with additional scientific experiments remained an anathema to the Astronaut Office and would clearly remain secondary to the safety of the crew and completion of the main objectives in any case.

Nevertheless, the idea began to gather momentum among the scientific community at NASA and the search for suitable experiment proposals began in the summer of 1963. The orbital flights of Project Mercury had included a number of small, relatively simple experiments, observations and activities, but there would now be a more focused effort to add several experiments to each Gemini mission, especially for the longer flights. The organization of this effort fell to the NASA Office of Space Science in Washington who, together with the Office of Manned Space Flight, created the Panel On In-flight Scientific Experiments (POISE) to examine the merits of such a program. In January 1964, the Manned Space Flight Experiments Board was tasked with deciding which of the proposed experiments would be assigned to each mission, not only for Gemini but also on the early Earth-orbiting missions of Apollo. Additional advice on providing and preparing in-flight experiments was supplied by the MSC experiment panel, which had already discussed experiments for possible inclusion on Gemini 3 and 4 but had ceased its meetings after January 1964 due to the creation of the headquarters effort. Instead, the panel passed on its suggestions and findings for the challenges such a program would encompass.

For Gemini 3, the problem was simply the shortage of time available, both before the planned mission (which was then still expected to be flown by late 1964) and during the short flight itself, leaving little time for the crew to operate even the most basic of experiments. The Astronaut Office position was clear. Gemini 3 was a test flight and their argument had the benefit of previous experience to back it up. The potential problems of overloading the crew with anything but the simplest of tasks on a short, three-orbit mission could easily be understood by comparing the 1962 Mercury flights of Glenn and Carpenter. [11]

On Gemini 3, it seemed the answer lay in supplying experiments which required very little crew input; experiments which performed on their own and, ideally, were easy to prepare for the mission. The experiment panel thought that two unflown experiments from the cancelled three-day Mercury-10 mission would be suitable, though the Gemini Program Office expressed their doubts. These were a study of the effects of low gravity and radiation on cells and the study of the growth of cells in ‘zero-g’.[4]

A third experiment assigned to Gemini 3 focused on the difficulty of maintaining communications during the re-entry of the spacecraft through the atmosphere. This was also originally suggested for MA-10 and was tentatively assigned to Gemini 3 for some months before finally being assigned to the flight.

[4] ‘Zero-g’ was the popular epithet given to what we know today as microgravity. The other widely-used term was ‘weightlessness’. Neither of these are strictly correct, but they are recorded here to remain immersive to the terminology of the era covered in this book – i.e., the mid 1960s.

The final approval for experiments for Gemini 3, 4 and 5 came from Dr. George E, Mueller, NASA's Associate Administrator for Manned Space Flight, upon the recommendations of the MSC Experiments Board [12]

Burn, baby, burn

Another of the primary objectives of the Gemini 3 mission was to "demonstrate and evaluate the capability to maneuver the spacecraft in orbit." This was to be done by means of the OAMS and initially called for several OAMS firings, or 'burns'. This plan was amended just a few weeks prior to the mission early in 1965, when planners were asked to ensure that if the retrorockets failed, the spacecraft could re-enter the atmosphere with or without a retro burn and before the life-sustaining consumables ran out. Called a 'fail safe orbit', this crew survival profile would see the spacecraft automatically re-enter the atmosphere relatively quickly after their planned descent opportunity had failed.

This scenario might have seemed dramatic, but the specter of being stranded in space remains a real threat even in today's space missions. Even with redundancy and improved reliability, back up plans and contingency operations, possible rescue spacecraft and a lot of simulations, there remains the very real possibility of a catastrophic failure in orbit stranding the crew beyond all hope of rescue.

Despite this late fail-safe caution, Gemini operated in a low enough orbit not to be permanently aloft and so re-entering the atmosphere was inevitable, but as safety was paramount the fail-safe contingency was rapidly inserted into the Gemini 3 flight plan. During the mission, the first firing of the aft thrusters would push the spacecraft free of the second stage of the Titan, adding some 10 ft./sec (3 m/sec) to its velocity and allowing the spacecraft to enter an elliptical orbit of 75 by 113 miles (122 by 182 km). As the first orbit neared completion, about an hour and 30 minutes into the flight and with Gemini 3 over Texas, the forward thrusters would be fired in a short burst to reduce the velocity by 65 ft./sec (20 m/sec) and drop the spacecraft into a lower, near circular orbit of 75 by 81 miles (122 by 130 km). Then, fifty minutes later on the second orbit as Gemini 3 flew over the Indian Ocean, there would be a series of out-of-plane burns totaling no more than 13 ft./sec (4 m/sec), which would be part of the earlier plans to check out the OAMS hardware but would not form part of the fail-safe procedures. During the third orbit, this time over Hawaii, the final OAMS burn would be a pre-retrofire burn designed to reduce velocity by 92 ft./sec (28 m/sec) and place Gemini 3 back into an elliptical re-entry orbit with a perigee of 39 miles (63 km).

Sit Down or Stand Up? - That is the question

Another topic raised during preparations for the first manned flight was whether the astronauts should open the hatch, with one of them (perhaps Pilot John Young) standing up in the seat to perform a very minimal excursion pending a full spacewalk, possibly on Gemini 4. During 1964, there was support for this idea of a stand-up EVA, but as Gemini 3 was scheduled for just three orbits it was felt that there would not be enough time in the mission to include even a hatch opening exercise. As Young recalled in his 2012 autobiography, while he had performed some early parabolic zero-g tests to evaluate getting out of and back into the spacecraft after his selection to Gemini 3, "I don't think Gus really ever wanted to put it in our flight." [13]. However, during November 1964, while performing altitude chamber tests at McDonnell in St. Louis and in support of preparations for the Gemini 4 mission, which was looking to include at least a stand-up EVA, Young opened his hatch at 40,000 feet (12,000 m), but then found difficulty in closing it again. This was something that would plague the Gemini 4 astronauts. It was useful experience, even though McDonnell engineers were not in favor, as Young later put it, "of bagging a couple of astronauts in the altitude chamber." [14] As it was pointed out, if a simulated exercise could not be conducted easily and safely in the altitude chamber, then there should be no thought of attempting an EVA in orbit. While the altitude chamber hatch opening test went ahead and provided useful knowledge for Gemini 4, the shortage of flight time for Gemini 3 meant that both men would remain inside their spacecraft with the hatches firmly closed until they were safely back on the ocean.

TRAINING THE CREW

The formal assignment of the four astronauts to the prime and backup crews of Gemini 3 did not mean their training commenced on that date. Their training for spaceflight had actually begun shortly after reporting to NASA as a member of their new astronaut group; since 1959 for Grissom and Schirra and since 1962 for Young and Stafford. Knowledge of Mercury systems and procedures and their flight experience certainly helped both Grissom and Schirra, but all four men were now embarking on a new mission-specific training program and for a new spacecraft, pioneering the processes that another 18 teams of astronauts (nine prime and nine back up) would soon be embarking upon for their own missions.[5]

The training for Gemini 3 can be defined by several categories, including: tests involving the actual spacecraft; the use of simulators to approximate and duplicate aspects of the planned mission; and specialist or part-task training which enhanced the crew's preparedness to meet the challenges of their given mission. Then there were the numerous briefings and lectures on various aspects of their flight, the hardware procedures and operations. [15] For this first crew, an important part of the training process was their feedback on the effectiveness of the program conducted both prior to and after the flight, so that improvements could be made (and unnecessary complications removed) to enhance future crew training programs and make maximum use of the program's limited resources and time. The first phase of their training saw the four men travel to the McDonnell plant in St Louis, for training in the Gemini mission simulator located there.

Spacecraft Tests: This included time spent actually inside the flight spacecraft, which for the prime crew totaled about 35 hours, as well as many times that outside as monitors, participants and observers, both at McDonnell Aircraft Corporation and down at Cape Kennedy.

[5] This does not include the original Gemini 9 crew of See and Bassett, who were killed in an aircraft accident at the McDonnell plant in St. Louis on February 28, 1966.

Table 4.2 Astronaut Participation Gemini 3 Spacecraft Tests

Test Program Completed	Site Location	Participating Crew	Time hrs:min
System assurance	St. Louis	Prime	3:00
		Backup	3:00
Simulated flight	St Louis	Prime	2:00
Altitude chamber	St. Louis	Prime	9:30
		Backup	5:00
Pre-mate simulated flight	Cape Kennedy	Prime	7:30
Joint combined systems	Cape Kennedy	Prime	6:00
		Backup	2:00
Pilot ingress dry run	Cape Kennedy	Backup	1:30
Flight configuration mode	Cape Kennedy	Backup	1:15
Wet mock simulated flight	Cape Kennedy	Prime	2:45
Final simulated flight	Cape Kennedy	Prime	2:30
		Backup	4:00
Countdown	Cape Kennedy	Backup	3:30
		Total hours Prime crew:	33 hours 15 minutes
		Total hours Backup crew:	20 hours 15 minutes
		Combined total hours:	53 hours 30 minutes

Information courtesy Gemini Program Mission Report GT-3 Gemini 3, NASA MSC, MSC-G-R-65-2 April 1965.

Gemini Mission Simulator: From April to June 1964, each of the Gemini 3 astronauts logged several hours in the Gemini Mission Simulator Number 2 (GMS-2) located at St Louis, Missouri. This was not an exact replica of Gemini 3, so their experience was focused primarily upon learning the general layout of systems and their operation. The prime crew logged 36 hours in this simulator and the backup crew 34 hours. On July 10, the simulator was disassembled, taken to MSC and reconfigured to match the specifics of Gemini 3. A different simulator was installed at the Cape, which was planned to be up and running for crew training in mid-July when the first simulator was relocated to Houston. However, this was not completed until October and after a month of checks, the Gemini 3 crew finally began training on the Cape simulator from November 9. For the remaining four months prior to launch, each of the four crewmembers logged an additional 80 hours of simulator training, half of this while wearing the Gemini pressure garments. In particular, this simulator was used for replicating the launch phase of the mission and for in-orbit training, consisting of repeated practice of critical on-orbit tasks and rehearsing elements of each of the three planned orbital activities. On the whole this training was adequate, but there were a few training equipment shortfalls and their lack was reflected in the crew's in-flight activities. This simulator was part of a complex, with the flight simulator configured to replicate the inner layout of a Gemini spacecraft so that the crew inside could experience almost all the views, sounds and vibrations they were expected to experience, from the moment of climbing into the spacecraft before launch to leaving the spacecraft after splashdown.

John Young (left) and Virgil Grissom in the Gemini mission simulator at McDonnell Aircraft Corp., St. Louis, Missouri. The simulator provided Gemini astronauts and ground crews with realistic mission simulations during intensive training prior to launch. (Courtesy Ed Hengeveld)

In January 1963, each of the seven Mercury astronauts and the nine new Group 2 astronauts had been assigned technical duties with the Astronaut Office. Grissom had received an assignment to trace the development of Gemini and, partly because of his experiences in Mercury, he was already familiar with many of the McDonnell engineers and technicians who had moved from Mercury to Gemini. As the astronaut representative, the crew cockpit design was worked around Grissom, including the displays and the view out of the window. In fact, Grissom had been so closely involved in the development of the Gemini over the previous three years that it became known affectionately as the "*Gusmobile.*" As a consequence, the first three spacecraft were built using his anthropometric measurements as a 75-percentile male in the sitting position.[6] This was fine, until other astronauts

[6]A percentile is a statistical measurement in which a variable for a population is divided into 100 groups with equal frequency. In this case, the 75th percentile is the value of the variable such that 75 percent of the relevant population is below that value. Such measurements are made to determine the size, volume and workspace area of human spacecraft, together with the size, posture, movement and mass of the human body.

Table 4.3 Summary of Gemini 3 Mission Simulator Training Time

Training Activity	Grissom	Young	Schirra	Stafford
	Hours (to nearest half hour)			
General familiarization (St. Louis)	36	36	34	34
Specific mission training (Cape Kennedy)	77.5	85.5	43	54
Total Hours	**113.5**	**121.5**	**77**	**88**
Suited hours as a portion of total hours	38.5	44.0	15	18
	Number of flight phases practices[1]			
Launch				
• Normal	20	21	11	12
• Mode I	7	7	3	4
• Mode II	32	33	29	37
• Mode III	7	9	3	5
Insertion				
• Normal	13	14	10	10
• Over speed	5	5	4	4
• Under speed	4	4	2	3
Orbit				
• Platform alignment	8	8	9	9
• Flight plan practice	9	9	5	5
Retrograde (manual control)				
• Retrofire	107	131	48	112
• Re-entry	64	71	35	45
Total Phases	**276**	**312**	**159**	**246**
	Number of system failures[1]			
Booster	51	53	23	28
Sequential	57	58	24	26
Electrical and communications	34	35	30	37
ACME	17	15	16	17
Orbital Maneuvering System	30	33	21	26
Reaction Control System	16	16	9	10
Guidance and Navigation	36	39	43	45
Environmental Control System	21	22	35	37
Total System Failures	**262**	**271**	**201**	**226**

[1]Both Command Pilot and Pilot received credit for each flight phase and each systems failure
Information courtesy: Gemini Program Mission Report GT-3 Gemini 3, NASA MSC, MSC-G-R-65-2 April 1965.

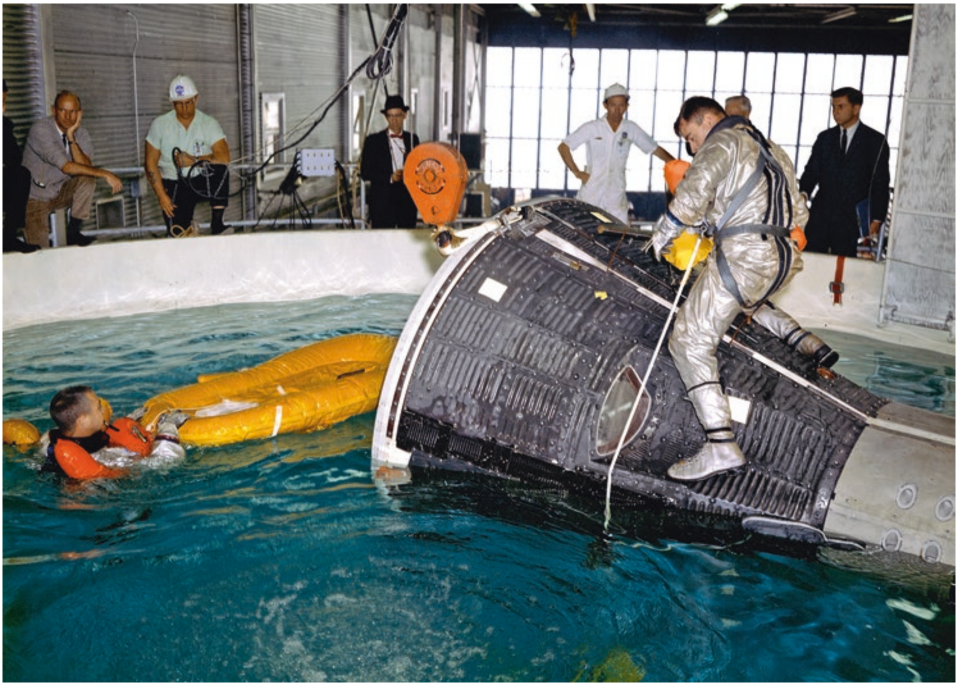
started using the simulator and tried to get into the early flight spacecraft, when it was realized that Grissom was one of the smallest astronauts and did not entirely represent the other 15. Fortunately, Young was not much taller than Grissom, but his seat still had to be compressed so he could fit in. For backup pilot Tom Stafford, however, who was one of the tallest of the group, both his seat and the spacecraft hatch had to be adjusted to allow him to close the hatch and be comfortable inside the spacecraft while wearing a pressure suit and helmet.

Designing the spacecraft based on Grissom's measurements proved not to be ideal when, just six months after the technical assignments had been made, it was found that 14 of the 16 astronauts in the office could not fit in the cabin of the Gemini. As a result, amendments had to be incorporated in all subsequent spacecraft. In addition, data from simulated weightless studies revealed that some individuals ‘grew’ up to two inches when in the prone position as their spine relaxed, a phenomenon which would occur over time on orbit in microgravity. Knowing this, it became clear that the sitting height in the crew compartment of Gemini needed to be enlarged. The problem was that the most obvious method for enlarging the spacecraft was an option that couldn’t be utilized, because the external geometry of the crew compartment had been fixed by the dimensions of the Titan launch vehicle, as was the crew seat configuration. With little time to resolve the problem, the solution was to redesign the egress kit, which contained an oxygen supply to be used in the event of ejecting from the capsule and rested on the seat structure. This was reduced by 1.75 inches (4.45 cm) by converting it into a flatter, machined container rather than one housing spherical bottles of oxygen. A further 0.75 inches (1.9 cm) was found by reforming the internal surface of hatch material, above the position of the seated astronaut in his pressure suit helmet. In fact, this adjustment also proved to be a useful aid for ingressing the spacecraft after EVA. [16]

The fact that every mission’s objectives were different meant that the simulator also had to be modified for each mission. This was particularly challenging for the simulator engineers when more than one crew required simulator time concurrently, due to the frequency of the missions.

Special and Part-Task Training:

- *Centrifuge*: This type of training, at the Naval Air Development Center, Johnsonville, Pennsylvania, addressed launch and re-entry acceleration profiles, where the crew controlled the ‘spacecraft’ under normal and abort scenarios. The Gemini 3 crew completed two of these sessions.
- *Launch Abort Training*: Each of the four astronauts completed two launch abort simulation programs on a moving base simulator. This simulator replicated vibration cues across a variety of abort situations, allowing the crew to experience the dynamics of these aborts and to define an optimum abort procedure for a variety of system malfunctions in either the launch vehicle or the spacecraft.
- *Parachute*: Replicating a Mode 1 Abort scenario, each of the four astronauts completed a number of personal parachute tows, with an attendant release to drop into water or on the land.
- *Egress*: To practice exiting the spacecraft after splashdown in both nominal and abort situations, the astronauts used Boiler Plate 201 and Static Article #5 for water egress training. This training was completed in stages in the floatation tank at MSC or out in the Gulf of Mexico, initially with briefings, films and demonstrations of the hardware and procedures using egress and survival equipment, followed by shirt-sleeve practice and finally in full egress equipment, including pressure garments.
- *Planetarium*: The crews made two trips to the Morehead Planetarium in Chapel Hill, North Carolina, where they reviewed the entire celestial sphere, focusing upon those portions close to their launch date orbital track. The objective of this training was to provide the astronauts with a backup against failures in the spacecraft’s orientation and navigation system, the inertial platform or communications.



Water egress training. John Young is seen exiting the spacecraft, while Gus Grissom is holding on to the life raft at left.

- *Briefings*: A series of formal briefings, lasting two or more days each, were held at MSC in Houston, Texas, McDonnell in St. Louis, Missouri, or Cape Kennedy in Florida. More informal briefings covered various phases of their training, flight plan reviews, medical aspects, experiments, certain procedures and operational reviews.
- *Homework:* Being an astronaut is never a nine to five, Monday to Friday job. Invariably, the nature of the role means that the workload piles up and spills over into what can be called 'family time' or 'down time'. More often than not, astronauts would arrive home after a long day of training sessions, simulations or briefings with an armful of paperwork and updates to the recent revisions to occupy them over the weekend. Paperwork piled up on their desks at MSC as well and, in the days long before laptop computers and electronic files, virtual reality and social media, the paperwork was literally on paper – and a lot of it. One astronaut, who shall remain nameless, jokingly commented to the author many years ago that, in the early days of the program, when the mountain of documentation fell off one end of the desk having been supplanted by more recent publications at the other end, it became clear that the documents on the floor were no longer required and could be filed, permanently.

Gemini 3 prime and back up crews pose with their Titan II/ GLV-3 launch vehicle following rollout inspection during a visit to the Martin Company in Baltimore in October 1964. Left to right: Young, Stafford, Schirra and Grissom. (Courtesy Ed Hengeveld)

Public Affairs and the Media

One of the hardest challenges in learning to become an astronaut, certainly in the early years, had nothing to do with the hardware, the medicals or the mission training. For many, it was what is now known as 'outreach', or public relations duties. With most of the early astronauts hailing from a strict military background, where signing an official secrets document and honoring the code of conduct was part of your soul, suddenly being thrust into the public limelight and being asked to 'open up' was not natural behavior to many of the country's new heroes. Indeed, none of them felt particularly heroic in just being selected, especially when many of their former colleagues and friends were on the other side of the world engaged in a war in south east Asia. Another challenge was learning to speak in public, offering support to workers and 'pressing the flesh' at meetings, functions and events. Just as challenging was dealing with the media, trying to present factual answers, avoid awkward or trick questions and remain positive. These were all new skills to be learned. Another tip the author was given by an astronaut many years ago, about surviving a question and answer session after presentations, was to give long answers to reduce the number of questions being asked, until you gained the confidence and experience to respond with quick, accurate and short replies.

Table 4.4 Summary of Gemini 3 Major Crew Training Activities

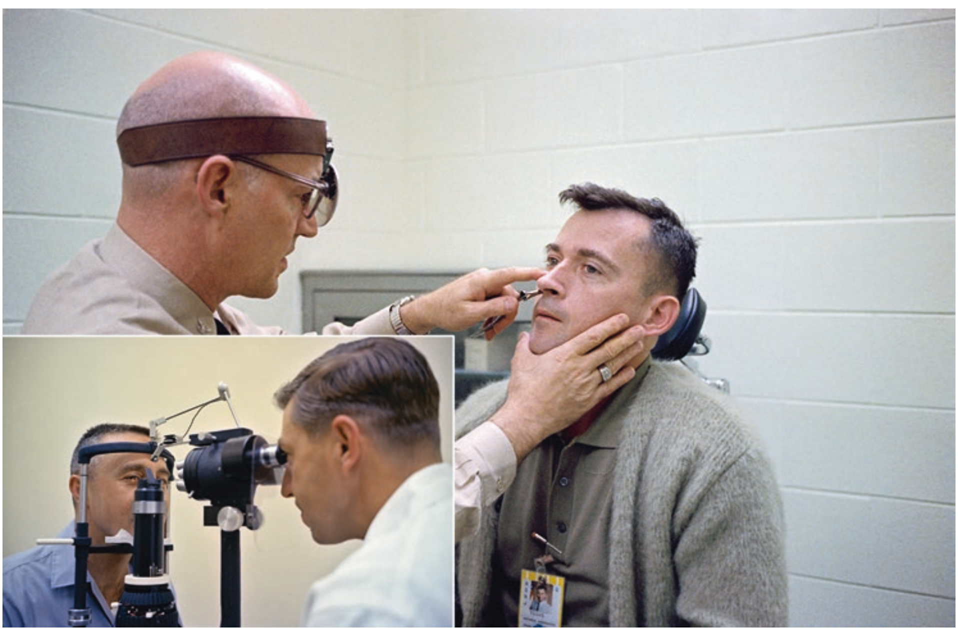
	Virgil I. Grissom			John W. Young			Walter M. Schirra			Thomas P. Stafford		
	Prime Crew Commander			Prime Crew Pilot			Backup Crew Commander			Backup Crew Pilot		
Training activity	**Hours**	**Sessions**	**Runs**	**Hours**	**Sessions**	**Runs**	**Hours**	**Sessions**	**Runs**	**Hours**	**Sessions**	**Runs**
Spacecraft testing (cockpit)	33	11		33	11		22	12		22	12	
Gemini mission simulator	113.5	59		121.5	62		77	39		88	44	
Parachute training			7			7			9			7
Egress exercises	16	4		16	4		12	3		12	3	
Launch abort training (LTV)	19		225	15		154	15		152	14		142
Centrifuge training (AMAL)	9.5	3	13	11	3	14	5	2	8	8.5	3	15
Planetarium (Morehead)	16	4		16	4		16	4		16	4	
SUB TOTALS	**207**	**81**	**245**	**212.5**	**84**	**175**	**147**	**60**	**169**	**160.5**	**66**	**164**
Spaceflight readiness flying	Approximately 25 hours per month for each crew member through the training period											
Briefings	Over 200 hours per crew member											

NOTE: Both the Command Pilot and Pilot received credit for each flight phase and each system failure.
Information courtesy Gemini Program Mission Report GT-3 Gemini 3, NASA MSC, MSC-G-R-65-2 April 1965.

Table 4.5 Gemini 3 Training Timeline April 1964 – March 1965

Date	Location	Training & Notes
1964 Apr-1965 Mar	Various	Total of over 200 hours of briefings
1964 Apr-1965 Mar	Jet proficiency flying	25 hours per month average
1964 Apr-1965 Mar	MSC Houston	Simulator #1
1964 Apr-Jun	McDonnell St Louis	Simulator #2
1964 May 10 & 11	McDonnell St Louis	Review mockup of cockpit
1964 Jun-Aug	Dallas, Ling-Temco Vought	All Astronauts - moving base abort simulator training
1964 Oct-1965 Feb	Various locations	Spacecraft egress training
1964 Oct-Nov	Gemini 3 spacecraft	2nd phase of system tests
1964 Nov-1965 Mar	Cape Kennedy	Simulator #2
1964 Nov-Dec	Centrifuges NADC, Philadelphia	Prime and back up crews worked in pressure suits
1965 Jan	Dallas, Ling-Temco Vought	Abort simulator
1965 Feb	MSC Houston	Refresher parachute landing
1965 Feb-Mar	Gemini 3 LC 19	Active spacecraft testing & egress and parachute training
1965 Mar 18	LC 19	Final sim flight

NASA released the following figures on Grissom's preparation for Gemini 3, highlighting the thorough training program: During the course of training between April 1964 and March 1965, for Gemini 3 alone, he flew 20 normal and 46 aborted launch profiles, 13 at normal speed insertion into orbit, 5 over speed and 4 under speed; he completed 8 platform alignments; 9 run throughs of the flight plan; 107 retrofires and 64 reentries. In addition, he experienced a total of 51 simulated booster failures and 211 system malfunctions: 57 were sequential, 34 electrical and communications related, 17 attitude and maneuver electronics, 30 orbital attitude and maneuver, 16 re-entry control, 36 guidance and control and 21 environmental control.



Two days prior to the scheduled launch, Gemini 3 pilot John Young undergoes an ear, nose and throat examination by Dr. L. Ballenberger, USN. [Inset] Meanwhile, Command Pilot Grissom undergoes an eye examination.

NASA could train the astronauts to fly in space, operate complex machinery, conduct numerous experiments and, eventually, learn tell the world about it. What could not be trained for (and still presents a challenge for every space explorer) was how to prepare the family for the adventure of being front and center in the space program and, more importantly, how to cope with life and new goals after they hung up their space suit.

After nine months of arduous training, it was time to go and fly the mission. In February of 1965, Grissom had said that both he and Young were ready. Officially, the launch was initially targeted for April or May, but it became clear that late March was becoming an option and both the men and the machines were ready to go. The four astronauts, Grissom, Young, Schirra and Stafford, flew down to the Cape on March 15. This was somewhat earlier than Grissom had expected, as there was still over a week to go before the planned launch on March 23, but he assumed that they were being given the opportunity to become as familiar with the Pad 19 facilities and procedures as possible.

During the week, they stayed at the brand new dedicated astronaut quarters in the Manned Spacecraft Operations Building on Merritt Island, where they took advantage of the gymnasium facilities to keep trim. They also regularly reviewed the flight plan, kept an eye on the weather and received updates on the status of the launch vehicle and their spacecraft. Grissom commented that these new facilities were a vast improvement over those at Hanger S during the Mercury days. As part of the aeromedical objectives for the mission, there were a number of pre-flight medical activities the crew had to perform. In the final two weeks prior to launch, Grissom and Young each performed three tilt-table studies, during which continuous ECG and pneumogram data was recorded and periodic blood pressure readings taken.[7] Neither astronaut suffered any ill effects from these tests.

Neither astronaut was placed under a strict medical supervision regime prior to their flight, nor were there any medical quarantine measures imposed. As one of the objectives of the mission was to evaluate the waste disposal system developed for the longer missions, it was decided not to impose a low residual diet on the crew. Therefore their preflight diet was a normal one, high in protein but moderate in carbohydrates. Three weeks prior to the mission, both the prime and back up crew members had been tested with each medication included in the onboard medical kit. All the drugs tested were administered orally, with no adverse effects or sensitivity recorded.

At ten days and again at two days prior to the mission, a medical specialist team completed comprehensive medical examinations on the prime and back up crewmembers, both to establish a preflight baseline and to determine their fitness to fly.[8] Young exhibited a slight rise in his heart rhythm, but it was not considered a serious enough condition to disqualify him from the mission. No other significant findings were recorded in any of the four men. [17]

[7] A pneumograph is an instrument used to record movements made during respiration.

[8] The medical specialist team included a radiologist, a neuropsychiatrist, a dentist, an ophthalmologist, an otolaryngologist, an internist-cardiologist and a flight surgeon.

MISSION RULES AND OBJECTIVES

As the preparations for the flight progressed, the mission rules and the First and Second Order objectives were fully defined. The fifth and final issue of the mission guidelines for Gemini 3 was issued on March 4, 1965, just three weeks prior to the mission. [18]

The purpose of Gemini 3, the document stated, was to "demonstrate the capabilities of the spacecraft systems and evaluate procedures necessary for the support of future long-duration and rendezvous missions."

The First Order mission objectives for Gemini 3 were:

A. Demonstrate manned orbital flight in the Gemini spacecraft and further qualify the spacecraft systems for future manned missions.
B. Evaluate the two-man Gemini design and its effects on crew performance capabilities.
C. Demonstrate and evaluate the operation of the worldwide tracking network with spacecraft and crew.
D. Demonstrate the capability of maneuvering the spacecraft in orbit using the Orbital Attitude and Maneuvering System (OAMS).
E. Demonstrate the capability of controlling the re-entry flight path and the ultimate landing point.
F. Evaluate the performance of the following spacecraft systems:

   1. Crew station controls and displays.
   2. Environmental Control System (ECS).
   3. Guidance and control systems (less radar).
   4. Electrical power and sequential systems.
   5. Propulsion system.
   6. Communications and tracking systems.
   7. Pyrotechnic systems.
   8. Instrumentation systems.
   9. Food and water management systems.
   10. Landing and recovery systems.

G. Demonstrate systems check-out, pre-launch and launch procedures for a manned spacecraft with a two-man crew.

The Second Order objectives for Gemini 3 were:

A. Evaluate the following spacecraft systems:

   1. Gemini spacesuits.
   2. Astronaut equipment.
   3. Biomedical instrumentation system.
   4. Personal hygiene system (partial).

B. Execute the following experiments:

   1. Experiment S-2, sea-urchin egg growth.
   2. Experiment S-4, radiation and zero-g effects on blood.
   3. Experiment T-1, re-entry communications.

C. Evaluate the effects of the low-level longitudinal accelerations (pogo oscillations) of the launch vehicle.
D. Obtain general photographic coverage in orbit for engineering evaluation.

The final Voskhod and the last Ranger

Just nineteen days after this directive was issued, Gemini 3 stood atop its Titan launch vehicle awaiting its human cargo to board for a flight into the history books. But as the days of March slipped by, two other events immediately prior to Gemini 3 caught the public imagination.

The first was the launch of the Soviet Voskhod 2 on March 18, carrying cosmonauts Pavel P. Belyayev and Alexei A. Leonov. During the second orbit, Leonov entered a pressurized airlock attached to the side of the crew compartment and Belyayev closed the hatches between them. Dressed in a spacesuit with an autonomous life support system, Leonov then depressurized the tunnel-like airlock and opened the outer hatch to float into open space for the first time. Connected to the spacecraft by a cable, he tumbled at the end of the tether for about ten minutes, describing his views of Earth and space and examining the exterior surface of the Voskhod while a fixed TV camera filmed his exploits. The Soviets initially reported that he successfully re-entered the airlock and sealed it and then, after re-pressurizing it, opened the inner hatch and entered the Voskhod to be congratulated by Belyayev. He had spent about 20 minutes in vacuum, of which just ten minutes was spent outside. What was not revealed until some years later was the difficulty that Leonov had in getting back inside, due to the unexpected ballooning of his suit. He had needed to lower his suit pressure to a dangerous level in order to bend it inside the cramped confines of the airlock. It was heroic, but lucky, that he was able to struggle back inside after much physical effort. After the EVA, the hatches were sealed and the airlock jettisoned.

After just 26 hours in flight and only 17 orbits, Voskhod 2 returned to Earth. They had completed one more orbit than planned and they landed well outside the normal area due to a late retro engine burn, leaving the cosmonauts isolated in the northern Ural Mountains between two large spruce trees and in snowdrifts up to 10 feet (3.048 m) deep. Inevitably, the Soviets did not disclose how close the landing had come to disaster for some time, with official reports indicating that the entry and landing had been successful. Just two Voskhod craft had flown with crews and in each case the cosmonauts had cheated potential death and disaster in the stripped-down Vostok. Though more Voskhod missions were planned, the Soviet leadership was eager to move on to the more capable Soyuz, so no more were flown. NASA and the West were unaware of this at the time, however, which led to even more speculation about the capabilities of the Soviets and supposition about their plans. [19]

On the day Voskhod 2 landed, the Syncom II communication satellite was successfully tested as part of the Gemini 3 mission simulation, using a communications link between the spacecraft, the Syncom II and the Cape. In the days before constant communications link via relay satellites in orbit, NASA had to devise an ingenious method of relaying data and voice communications from the spacecraft around the world to MCC. The telemetry signals and voice messages were to be relayed from the spacecraft on the mission to the surface ship USNS *Coastal Sentry Quebec*, located in the Indian Ocean.[9] From there, the signals would be fed to the Syncom surface station a few miles away on the USNS *Kingsport* (T-AG 164), then on up to Syncom II in geostationary orbit 22,300 miles (35,880 km) above the Indian Ocean, back down to the ground station at Clark AFB in the Philippines and then via cable to a NASCOM (NASA COMmunications network) station on the Hawaiian island of Honolulu. From there, another cable relay would take the signal across the Pacific Ocean to the United States mainland, followed by a land line to Goddard Space Flight Center in Maryland and then finally on down to MCC at the Cape in Florida. At the same time, *Coastal Sentry Quebec* would transmit a high frequency radio signal direct to a NASCOM station at Perth, Australia, after which a cable would carry the data to the NASCOM station at Honolulu. From there, the better of the two transmissions would be forwarded to the Cape via Goddard. [20]

Two days later, on March 21, NASA's Ranger IX, the final mission of the series, was launched successfully from the Cape by Atlas-Agena B, initially into Earth parking orbit. Then it was boosted by a second burn of the Agena B to an escape velocity of 17,500 mph (28,157.5 kph), allowing the unmanned lunar probe to continue on its 2.5-day, quarter-of-a-million-mile one-way trip to the surface of the Moon. It arrived on March 24, the day after Gemini 3 flew.

On the eve of the first manned Gemini launch, with world headlines still marveling at the exploits of cosmonauts Leonov and Belyayev, editor Robert Holz wrote in the editorial of the *Aviation Week and Space Technology* that although the mission of Voskhod 2 was continuing when the issue went to press (he was unaware that it would be over in 24 hours), "it had already opened a new chapter in the history of man's conquest of space." Holz added, "This history will be written primarily in the Russian Cyrillic alphabet, with only an occasional U.S. footnote technically necessary... All of this Soviet progress again emphasizes strongly the ultra-conservatism of the U.S. manned space program and the utter inadequacy of the tiny step-by-step approach… [which is] sounding more and more idiotic in the face of Soviet space achievements." These strong words were based on the initial evidence of the apparent leaps and bounds the Soviets were making and the slow pace of Gemini. Holtz went on to criticize the management of NASA and its delays in taking the leadership in space from the Soviets, in spite of spending billions of dollars of taxpayer funds. In truth, the Soviet program was struggling and its successes as they were perceived in the West were little more than a façade, although it would be some time before that reality was revealed. [22] If that was not enough of an 'own-goal', there was further criticism from a leading U.S. newspaper. In the editorial of the *Washington Daily News*, also on March 22, Samuel Lubell wrote that fifty percent of the people interviewed by the paper in recent weeks (the exact number of interviewees was not revealed) had stated that funding for trips to the Moon should be the first part of the Federal Budget to

[9] USNS stands for United States Naval Ship, meaning that it was a vessel owned by the USN that was not commissioned. In the NASA system every tracking station had a three-letter designation, so both *Coastal Sentry* and NASA's other ship *Rose Knot* (T-AGM-15) had to adopt a third word into their names. The 'Q' for Quebec and 'V' for Victor from the phonetic alphabet were applied to *Coastal Sentry* and *Rose Knot* respectively, though no one can remember why these two names in particular were chosen. [21]

be cut. In a poll taken prior to Voskhod 2 and later in the American reaction to that flight, another third of those polled stated that spending on space exploration should be cut. [23]

Hopefully, down at the Cape, Grissom and Young were spared from having to read these less than supportive comments of what they were about to do. Though they did not know it at the time, Gemini 3 would be the point at which America began to catch up the deficit to the Soviets. Its success, together with that of Ranger IX the following day, helped restore some pride in the American space program, but there remained so much to do amid growing signs of difficult times ahead for America both at home and abroad.

Gemini 3 is hoisted to the White Room on Pad 19. (Courtesy Ed Hengeveld)

CRISIS AT CARNARVON

As the launch of the Gemini 3 mission drew near, the remote tracking site teams were deployed. With three orbits planned, both the Australian site at Carnarvon and the one on the island of Hawaii were to play an important part, as Grissom and Young would be communicating with these sites prior to the de-orbit and entry phases of their mission. In these early days of the program, the remote sites communicated with the astronauts in orbit directly, or relayed communications from Mission Control at the Cape. Normally, there would be a serving astronaut manning the Capsule Communicator (Capcom) console at both the MCC and out at the remote sites.

Heading the team out at Carnarvon was Dan Hunter, a man with a strong personality and a firm belief in his role, who often clearly stated his opinion but would follow the procedures and perform to the best of his ability; important character traits in the remoteness of the Australian outback. Five days prior to launch, the Carnarvon and Hawaiian teams were dispatched to their stations in preparation for their roles during Gemini 3.

Arriving in Carnarvon for the first time, after 54 hours of travelling from Houston, astronaut Pete Conrad recalled getting off the plane and having his bags thrown out onto the red dirt, then being told by the crew that they would pick him up on their way back and watching the plane take off in a cloud of dust. When he checked into the local hotel he asked for the reservation in his name, only to be told to take the first room that he found made up on the second floor and then let the girl behind the desk know which one he was in on his way out. [24]

Conrad, one of the nine new Group 2 astronauts and one of the stronger characters in the Astronaut Office, was there to serve as Capcom. Fellow Group 2 astronaut Neil Armstrong had been dispatched to the Hawaii station for the same reason. In these early days of the program it was thought, primarily by Shepard and Slayton, that only astronauts could serve in the role and be capable of direct communications with a crew in space, especially during time-critical or stressful situations. This included manning not only the Capcom console at Mission Control in the U.S., but also at the remote sites. Gene Kranz disagreed: "My remote teams had matured," he wrote in 2000. "In my view, astronauts assigned to remote sites were observers given the job of assisting the controllers if that became necessary."

Three days prior to the launch of *Molly Brown*, the strong personalities of Conrad and Hunter clashed over exactly who was in charge at Carnarvon, with the situation coming close to exchanging blows. The episode escalated quickly, so much so that when Kranz learned of the situation back at the Cape much later that night, he found Deke Slayton and Chris Kraft having their own verbal dispute over the problem outside their apartments. Hunter had stated quite clearly that Kranz had put him in charge and that if he had any more trouble from Conrad he would throw the astronaut out of the control room. Conrad was not going stand for that and told Hunter that Slayton had told him that he (Conrad) was in charge in Carnarvon. This argument raged into the early hours before Slayton and Kraft calmed down. Neither backed down, although Kraft did say he would set guidelines for the teams out at Carnarvon and Hawaii the next morning.

The next day, Kranz spoke with Hunter, who said that Conrad had tried to take over and that the maintenance and operation staff, as well as the station manager, had asked Hunter to clarify who was really in charge. They wanted a written confirmation to cover their backs. With such a short time to go before the mission, Kranz thought the issue could be glossed over until after the flight. He was wrong. In the meantime, he and Kraft drafted a message which defined the role of the Capcom at the remote sites, one which clearly put Hunter in charge of proceedings. When Slayton heard this, he was fuming and the argument flared up again, this time in Mission Control and in front of the controllers assembled there. Slayton was adamant that if astronauts were to be sent to such remote places then they should be in charge, but Kraft cut him off and came up with an interim solution for this mission: Hunter was to be in charge of site operations and Conrad in charge during the real-time phases of the mission. When the two men learned of this decision out in Australia, neither of them were happy about it.

Kranz wrote that this division between controllers and astronauts became more obvious during the launch-minus-one-day briefing, when, totally oblivious to the furor going on in the background, Grissom and Young had invited astronauts and controllers to a brief social gathering, a chance to relax prior to the flight. Instead of the usual mixing and mingling, the controllers occupied one side of the room and astronauts the other. Later, apparently after Young and Grissom had left, more tense words were spoken between some of the individuals. "This was no way to run a mission," wrote Kranz, adding that he hoped that a more professional character would emerge for the launch and mission the very next day. "We need a united team, controllers and astronauts, at every site, in the control center and in the spacecraft," he commented. Fortunately, the flight went without any major hitch, but the episode at Carnarvon drew attention to a potentially volatile situation. The close proximity of their working environment, the relentless pressure of the program, plus large egos and stubborn pride, sometimes pushed the teams to boiling point. As Kranz recalled: "I sometimes wondered why an occasional bloody brawl didn't break out." [25]

Table 4.6 Gemini 3 Flight Control

COMMAND STAFF
Christopher C. Kraft Jr. Assistant Director Flight Operations MSC, Gemini 3 Mission Director & Flight Director
Lt. General Leighton I. Davis, USAF Manager DoD Range Division & Manager Manned Spaceflight Operations
Major General Vincent G. Huston, USAF Commander Eastern Test Range
Ernest Amman U.S. Weather representative
Paul Haney, PAO NASA Assistant Information Director for Mission Commentary
MISSION CONTROL CENTER TEAM
Christopher C. Kraft Jr. Flight Director
Eugene F. Kranz Assistant Flight Director
Manfred von Ehrenfried ('Dutch'); Lawrence L. Armstrong Operations and Procedures
Captain R. B. Sheridan, Captain A. Piske, and Captain W. E. Arellano Network Controllers (all attached to the Air Force Systems Command)

(continued)

Table 4.6 (continued)

FIDO – Clifford E. Charlesworth, Jr. and Glynn S. Lunney
GUIDO – Arnold D. Aldrich and Gerald D. Griffin
RETRO – John S. Llewellyn Jr., and Jerry C. Bostick
Switchover Monitors – Charles B. Parker and Thomas F. Carter, Jr.
EECOM – Richard D. Glover, John W. Aron and Larry Bell
BOOSTER systems – William E. Platt
CAPCOM – (astronaut) L. Gordon Cooper, Jr.
Booster Tank Monitor – (astronaut) Eugene A. Cernan
SURGEON – Charles A. Barry, MD, MSC & Major J. R. Wamsley, USAF
NASA Recovery Coordinator – Robert F. Thompson

MONITORING TEAM AT MSC HOUSTON, TEXAS

John D. Hodge
Flight Director

J. W. Roadh
Assistant Flight Director

J. H. Temple
Operations & Procedures –

Surgeon – Dr. D. O. Coons
Capcom – (astronaut) Roger B. Chaffee
Guidance & Navigation – D. T. Lockard
EECOM – T. R. Loe
Booster Monitor – S. M. Present
Booster Tank Monitor – (astronaut) C. C. Williams, Jr.
Guidance – K. W. Russell and W. E. Fenner
RETRO – D. V. Massaro
Network Controller – H. E. Nicols

REMOTE SITES

Canary Island; Carnarvon, Australia (Capcom astronaut C. Conrad Jr.)
Kauai, Hawaii (Capcom astronaut N. A. Armstrong)

Corpus Christi, Texas; Guaymas, Mexico; *Rose Knot Victor* (East of Hawaii); *Coastal Sentry Quebec* (Indian Ocean)

	Canary	Carnarvon	Hawaii	Texas	Mexico	RKV	CSQ
Command Communicators	YES	YES	YES	YES	YES	YES	YES
System Engineers	YES	YES	YES	YES	YES	YES	YES
Astronaut Simulator	YES	YES	YES	YES	YES	YES	YES
Flight Surgeons	YES	YES	YES	YES	YES	YES	YES

MISSION CONTROL CENTER SUPPORT GROUP

- Telemetry Room
- Command Room
- Air-to-Ground Equipment Room
- Data Select Room

Also in support: Network Room
Data Analysis & Flight Control Briefing Room
Communications Center
Gemini simulator

Data obtained from NASA News Release MSC 65-44 (Undated)

Table 4.7 Gemini 3 Remote Tracking Station Assignments

Station → Position ↓	**Grand Canary Island (CYI)**	**Carnarvon, Australia (CRO)**	**Kauai Island, Hawaii (HAW)**	**Corpus Christi, Texas (TEX)**	**Guaymas, Mexico (GYM)**	***Rose Knot Victor* (ship) (RKV) (East of Hawaii)**	***Coastal Sentry Quebec* (ship) (CSQ) (Indian Ocean)**
Command 'Capcom'	A. J. Roy, Jr. (FCD, MSC) A. S. Davis, (Philco)	D. S. Hunter (FCD, MSC) J. P. Vick (FCD, MSC)	J. L. Tomberlin (FCD, MSC) P.L. Ealick (FCD, MSC)	K. K. Kundel (FCD, MSC) R. F. Robertson (Philco)	C. R. Lewis (FCD, MSC) G. B. Scott (FCD, MSC)	E. I. Fendell (FCD, MSC) L. E. Mercier (FCD, MSC)	W. D. Garvin (FCD, MSC) H. E. Porter (FCD, MSC)
System Engineers	Gary E. Coen, (FCD, MSC) A. W. Barker (Philco)	T.A. White (FCD, MSC) W. M. Merritt (FCD, MSC)	J. F. Moser (Philco) C. A. Link (Philco)	D. L. Klingbeil (Philco) G. M. Bliss (FCD, MSC)	G. F. Muse (FCD, MSC) H. B. Stephenson (FCD, MSC)	H. Smith (Philco) J. Fuller (FCD, MSC)	J. E Walsh (Philco) F. E. Claunch (Philco)
Astronaut Simulator	J.E. Saultz (FCD MSC)	B. H. Walton (FCD, MSC)	J. R. Fucci (Philco)	W. E. Emerson (Philco)	E. L. Dunbar (Philco)	H. V. Berlin (Philco)	H. R. Perkins (Philco)
Surgeon	Capt. E. L. Becjman USN Lt. Col. R. H. Shamburek US Army	Maj. R.A. Pollard, USAF (MSC) W.Cdr A. J. Bishop, RAAF Sq Ldr Dr. Murray Alston, RAAF	Dr. D. E. Catterson, (MSC) Lt. Col. R. Unger USAF	Maj. R. M. Chubb, USAF Lt. G. A. Humbert, USN	Maj. R. R. Burwell, USAF Maj J. E. Hertzog, US Army	Dr. G. F. Kelly (MSC) Maj. D. E. Graveline, USAF	Dr. C. A. Jernigan (MSC) Maj. G. D. Young Jr., (FCD, MSC), USAF
Observer/ Astronaut Capcom	-	Charles 'Pete' Conrad Jr.	Neil A. Armstrong	-	-	-	-

GEMINI FLIES! THIS TIME WITH A CREW

On the morning of March 23, 1965, with Ranger IX on the way to the Moon and the FAA special regulation in place banning unauthorized aircraft of U.S. registry flying in the designated recovery and associated areas "during the time determined necessary for the safe conduct of the Gemini flight and recovery operation," the Floridian skies around the Cape and the recovery areas were clear. [26] The first manned Gemini prepared to fly.

The weather at the Cape looked good on launch day, with the prediction at 09:00 EST that the day would be partly cloudy with scattered and broken clouds, winds at 10 mph (16.09 kph) and local temperature at 68 degrees F (20 degrees C). The weather at the prime recovery area was also reported as satisfactory, with winds running at 5 to 20 mph (8.04–32.18 kph) and surface waves at 3 to 5 ft. (0.91–1.52 m) It was a good day to fly.

Overnight March 22 and into the early hours of March 23, backup crew members Wally Schirra and Tom Stafford had spent the night in the Pad 16 ready room of the Manned Spaceflight Operations building at nearby Merritt Island. They had joined the prime crew for dinner, together with Al Shepard, Deke Slayton, Gemini 4 astronauts Jim McDivitt and Ed White and their good friend and advisor Attorney Leo DeOrsey, then retired shortly afterwards. Grissom and Young, after watching TV for a short while, reviewed their flight plan once again after dinner before retiring themselves at about 21:00.

March 23: Launch Day!

It was an early start, with the prime crew being awoken at around 04:40 by Deke Slayton. Then, after ten minutes of pre-flight medicals by NASA flight surgeons "to see if we were still warm and breathing," Grissom surmised, they showered and dressed in casual clothes. Then it was time for breakfast with a number of specially invited guests:

Mr. Bastian 'Buzz' Hallo, Gemini Program Manager of the Martin Company.
Colonel Richard C. Dineen, Gemini Program Manager, Air Force Systems Division, who was responsible for the preparation of their Titan launch vehicle.
Dr. Robert R. Gilruth, Director of the Manned Spacecraft Center.
Walter C. Williams, Vice President of Aerospace Corporation and the former operations director throughout Mercury.
Walter F. Burke, Vice President of McDonnell Aircraft Corporation, makers of the Gemini spacecraft.
Christopher C. Kraft, Mission Director for Gemini 3.
Dr. Charles A. Berry, Chief of the medical effort for Gemini.
Mr. James S. 'Mr. Mac' McDonnell, the board Chairman of McDonnell Aircraft.
Alan B. Shepard, Chief Astronaut, Astronaut Office, MSC.
Deke Slayton, Assistant Director, Flight Crew Operations, MSC.
Mr. Charles W. Mathews, Gemini Program Manager for MSC.
Mr. G. Merritt Preston, Deputy Director of KSC.

The astronauts' breakfast included tomato juice, cantaloupe, scrambled eggs, a 2 lb. (0.9072 kg) porterhouse steak – both cooked medium rare for the crew – toast, jelly and coffee or milk. For their pre-flight drink, Grissom asked for milk while Young chose tomato juice and took nothing additional.

[Top] Gus Grissom (facing the camera, at the end of the table) is shown during the steak breakfast about two hours prior to the launch of Gemini 3. In the foreground are Donald K. Slayton (right) assistant director for Flight Crew Operations; and Walter Burke, general manager of McDonnell Aircraft Corporation Spacecraft and Missiles. In the background are astronaut Alan B. Shepard Jr. (left) and Walter C. Williams, former deputy director of MSC, but at this time working for a private aerospace firm. [Bottom] John Young at the other end of the table (center). Sitting at left is J.S. "Mr. Mac" McDonnell, board chairman and Chief Executive Officer of the McDonnell Aircraft Corporation, primary contractor of the Gemini spacecraft. At right is Dr. Charles A. Berry, chief of Center Medical Programs.

SUITED AND BOOTED

According to the Gemini 3 Press Kit, the space suit Grissom and Young would be wearing for the flight "was designed as a close fitting full pressure suit. The wearer can take off the helmet and gloves in flight. The remainder of the suit was designed for continuous wear. The communications systems (earphones and microphones) were also an integral part of the suit." [27]

Officially, the suit worn by the Gemini 3 astronauts was designated G-3C. It was intended only for activity inside the spacecraft (Intravehicular Activity or IVA) and could not be used outside the spacecraft on EVA (Extra Vehicular Activity, or spacewalking). That capability was a separate development and is explored in the next book in this series covering Gemini 4.

Developing a suit for Gemini

Following studies for advanced full pressure garments based upon the Project Mercury suit, the BF Goodrich Company developed an improved Mercury suit that was intended for Mercury-Atlas 10 and subsequent missions under contract NAS 9-252. This suit provided additional comfort and mobility and was designed for a pressurized duration of four hours and up to 14 days unpressurized, covering the requirements for Gemini. On April 13, 1962, the Goodrich GX-1G suit (G = Gemini, X= Experimental, 1 = sequence number, G = Goodrich) was delivered to NASA for evaluation.

GX-1G featured a mechanical visor seal with an in-flight feeding port in the helmet. The torso featured a nylon restraint layer and Neoprene bladder, with improved seals and a circumferential pressure sealing closure for donning (putting on) and doffing (taking off) the suit. There was an improved bio connection, stretch fabric knee areas and glove disconnects that were 1.5 inches (3.81 cm) closer to the elbow than in the Mercury suit. The whole suit was covered in a reflective aluminized fabric layer.

That same month, NASA issued two further contracts for advanced pressure suit development to Arrowhead Products Inc. (Contract NAS 9-253) and Protection Inc. (Contract NAS 9-254). A fourth company, David Clark, had declined to participate in the program as they were heavily involved in procuring the suit intended for the USAF X-20 Dyna-Soar program. However, Dyna-Soar was cancelled on December 10, 1963 and replaced by the Manned Orbiting Laboratory (MOL) Program, using a modified Gemini spacecraft (then identified as Gemini-X).

Requirements and design

The new suits were intended only for Earth orbital missions and had to be full-pressure anthropomorphic systems, compatible with a closed-system Environmental Control System (ECS). The design also had to incorporate facilities to provide the wearer with pressure protection, ventilation and body restraints in the event of either the loss of normal cabin environment or a possible emergency ejection from the spacecraft, which was being considered for Gemini. In addition, it had to be usable by the astronaut as an environmental "exposure garment" following an emergency descent, while also remaining comfortable when unpressurized for the planned long-duration missions.

The designs also had to feature increased mobility and have a reliable pressure sealing entry closure system, as well as a floatation system for use in the water if the spacecraft splashed down and the crew had to perform an emergency exit while awaiting recovery. An exterior reflective protection layer was also required, one that included suitable restraint devices and a parachute harness. [28]

All three companies submitted suit prototypes which were evaluated by NASA. The suit provided by Protection Inc. was a single, partial-wear, quick assembly full-pressure suit but its mobility, comfort and function were inferior to the capabilities of the suits from the other suppliers. Their contract was discontinued following the competitive evaluation. In August 1962, the suits from Arrowhead and Goodrich were evaluated in altitude chamber tests at Brook AFB, San Antonio, Texas, in a cooperative effort between NASA and the Air Force School of Aerospace Medicine at Brooks. These tests were also connected to evaluation studies of human endurance of up to 14 days and there were serious issues during the tests. These will be outlined in the Gemini 7 title of this series. The suits being tested featured removable arm and leg sections, an option that was under consideration for additional comfort during the planned 14-day missions. Arrowhead supplied a prototype partial-wear, quick assembly full-pressure suit, but various shortcomings regarding its bulk, the comfort of the wearers, failures of various components and its general workmanship meant that their contract was also terminated. Goodrich delivered the modified G-1G suit design on June 12, 1962, which was further modified and re-delivered on July 7, 1962. As a result, the Goodrich contract was amended in September 1962 and they delivered the GX-2G suit on October 7 that year. In December, the contract was amended yet again and a total of 14 G-2G suits were added to the contract. Suits 1 through 8 were used for modification and design changes in January 1963, with the G-2G-9 through G-2G-14 prototypes (6 suits) completed to support initial program requirements, such as testing the ECS at Air Research (2 suits), capsule mockup evaluations at McDonnell (2 suits), parachute harness qualification testing at El Centro, California (4 suits) and simulated off-the-pad testing (2 suits).

At this point (1962), the BF Goodrich G-2G was the only suit from the original three contractors to be supplied to NASA for further evaluation. However, the David Clark Company returned to the competition and requested an evaluation. They submitted a modified rear-entry S-951 suit, funded in-house, which featured the link-net technology which the company had incorporated for the USAF X-15 program (A/P 22S-2 suit configuration). This suit was designated the G-1C-1 (Gemini – 1 – Clark – 1). Later in the year, the mock-up review was conducted at the McDonnell plant, involving astronauts Gus Grissom, Elliott See and John Young. From their experiences, they recommended to the Gemini Program Office that the program should use the G-1C-1 suit from David Clark instead of the G-2G-8 design provided by Goodrich. Consequently, under contract NAS 9-1396, the David Clark Company delivered 14 G-1C-configuration and 16 G-2C-configuration suits for further evaluation, modification and development.

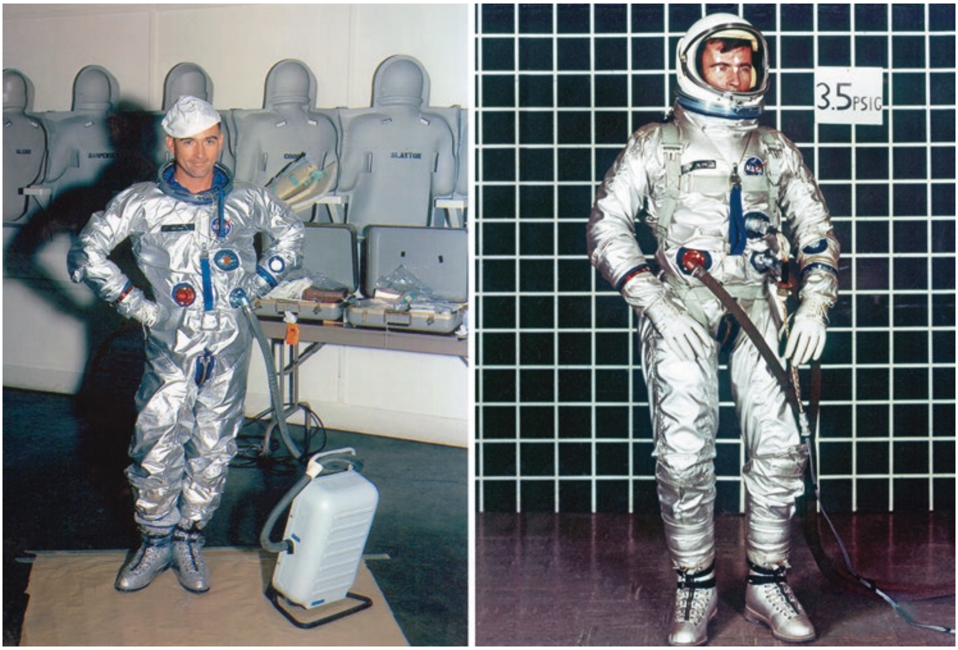
As the program developed, the G-1C suit (around 15 suits in various configurations of GX-1C and G-1C) was utilized for early evaluations and reviews, in which the 'crewmember' (who could be either a McDonnell employee or a NASA astronaut) was integral to the development of the Gemini crew compartment design. The G-1C was then superseded by 31 G-2C suits, which incorporated improvements from the earlier design and were used primarily in early training activities. This suit featured the 'silver' aluminized outer layer that had originally been selected as an aid to thermal control during the flight. The design was developed further and evolved into the G-3C version that was flown on Gemini 3, which replaced the aluminized layer with a white Nomex outer layer. At least 14 of the G-3C suit assemblies were manufactured. [29]

The G-3C suit featured an inner layer of a rubberized material with an outer covering of nylon. The supply of oxygen was provided by containers located in the Gemini Adapter Section, with air inlet and outlet connections located on the waist of the suit. When the Adapter Section of the spacecraft was jettisoned at the end of the mission prior to re-entry, the astronauts switched to an oxygen supply located in the Re-entry Module. Entry into the suit was via the zippered opening which ran from the crotch and up the entire back of the suit. According to the Gemini 3 press kit, three suits were provided for each astronaut. One was used during training, the second was worn during the flight and the third was held in reserve as a backup unit.

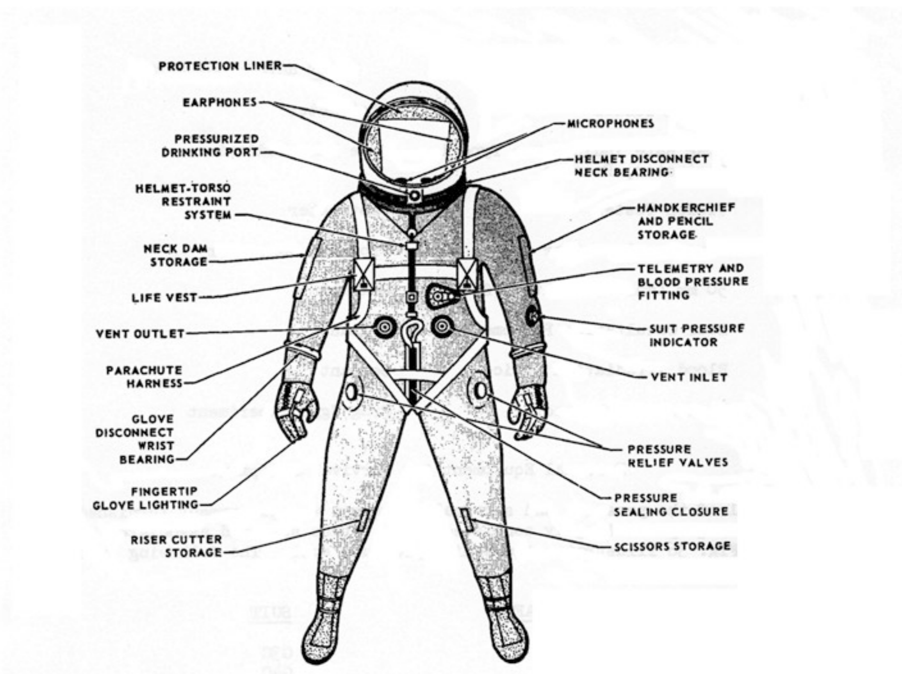
Rotating wrist joints allowed for full wrist movement and enabled the gloves to be attached to the suit arms. To assist in reading instruments during the night pass of each orbit when the cabin lights were turned off, individual fingertip lights were incorporated into the gloves. These were powered by a small battery pack. There were built-in pockets on the inside of each lower leg of the suit. The left leg pocket included a special pair of scissors to cut open the food packages, while the right leg pocket included a parachute shroud line cutter, which was available for use after a landing by parachute to prevent the astronauts becoming entangled in the parachute lines. The infamous 'Wolfie's sandwich' given to Young by Schirra was slipped into one of these pockets just prior to the launch.

Following Gemini 3, this suit was replaced by the G-4C suit that was capable of supporting EVA and was not planned to be used again. For Gemini 3, Grissom used suit G-3C-1, while Young wore suit G-3C-4.

Technical data:
Operating pressure (nominal):
3.7 psi (25.5kPa)
Pressured Garment Assembly (PGA) weight in 1g:
23.5 lb. (10.7 kg)
Life Support:
Both primary and backup was provided by the spacecraft's systems.



[Left] A jovial John Young models the new G-2C Gemini spacesuit, made by the David Clark Company. Note the molded couches in the background for the Mercury astronauts. (Courtesy Ed Hengeveld) [Right] In this image, taken in 1964, John Young demonstrates the mobility of the G-2C Gemini pressure suit, pressurized at 3.5 psi, at Lane Wells Building, Site #4, in Houston, Texas.



Details of the Gemini pressure suit.

Young is assisted into his suit, with the technician installing the required additions to the suit pockets during dress rehearsals on March 8, 1965.

After finishing their breakfast and receiving good luck wishes from their guests, Grissom and Young left the building and waved to the few onlookers before being driven the six miles (9.65 km) to Pad 16 in a two-car motorcade, arriving at the medical trailer at the pad at approximately 06:02. Grissom later wrote that they were running five minutes ahead in the schedule and that Chris Kraft had indicated that if all continued to go well the launch might occur at 08:30. While the astronauts were at Pad 16, the team of medics attached the heart and pulse sensors to their bodies, placing the 10 oz. (0.28 kg) amplifier designed to boost the medical data transmission signal into the small waist pockets of their long-john underwear. These sensors would record the astronauts' pulse, respiration, electrocardiogram and blood pressure during their flight. Both men were given a brief medical, which included donating pre-flight blood and urine samples, undergoing an electrocardiogram and recording their respiratory rate, oral temperature and blood pressure. Young was particularly careful when handing his urine sample over to nurse Dee O'Hara, mindful of an earlier incident when he had stored a similar sample in his briefcase, only to find that the cap had come loose and spilt the contents, soaking his papers in urine.

The suiting-up process, which was conducted in the same trailer at Pad 16, began almost immediately and was completed by 06:45 by suit technicians Joseph W. 'Joe' Schmitt and Alan M. 'Al' Rochford (see sidebar: *Suited and Booted*).[10] They were observed by illustrator Norman Rockwell, who had been hired by NASA to depict the suiting process. He took numerous photographs of the event, as reference material from which to create the famous image. In his desire for accuracy, Rockwell phoned Schmitt and Rochford a couple of days after the event to check that the process depicted in the painting was correctly synchronized with the time illustrated on the countdown clock. [30]

Before the crew left for Pad 19, the backup crew of Wally Schirra and Tom Stafford appeared for a last-minute briefing on the spacecraft and the weather. Both astronauts had been in the spacecraft since 03:00 that morning, checking the flight controls,

Backup command pilot Wally Schirra jokes with prime command pilot Gus Grissom (left) and pilot John Young, in the suiting trailer at Pad 16 on the day of launch. He tells them he is ready to fly in case they do not want to conduct the flight. Schirra is dressed in an old and worse-for-wear Mercury pressure suit and wears a number of access badges around his neck. In the background is Deputy Director of Flight Crew Operations Deke Slayton. (Courtesy Ed Hengeveld)

[10] Veteran suit technical Joe Schmitt passed away on September 25, 2017, aged 101. In a long and illustrious career, Joe Schmitt participated in the suiting up of every American astronaut from Al Shepard in May 1961 to the crew of STS-5 in November 1982.

communications link and other spacecraft systems. The formal update was enlivened by Schirra, the prankster of the Astronaut Office, who appeared wearing an old, beat up and far-from-pristine Mercury pressure suit that was ripped, patched up at the knees and elbows and missing some of its attachments. As Grissom recalled, Schirra calmly explained: "I have suited up, just in case you two chicken out and turn the mission over to the back-up team." [31] Just prior to departure Deke Slayton gave them the latest weather briefing.

At 07:05, the crew left Pad 16 for the short, 400-yard (367.76 m) drive along the Barton FREEway to Pad 19 (see sidebar: *The Legend of the Barton FREEway*), arriving at the Pad elevator a few minutes later. Young led Grissom on the walk to the elevator, together with suit technicians Schmitt and Rochford. They rode the elevator to the White Room on the 11th level of the gantry, where the astronauts were helped into the spacecraft ejection seats by the suit technicians at 07:12, just seven minutes after leaving the medical trailer at Pad 16, clearly justifying the creation of the new Barton FREEway. They were now running about five to ten minutes ahead of schedule. On hearing that, Spacecraft Test Director George Page joked that their early arrival must have meant they had missed breakfast, which the astronauts assured him they had not. Meanwhile, Tom Stafford had made his way to the blockhouse at Pad 19, where he would serve as communication contact between the crew in *Molly Brown* and the staff in the blockhouse. Wally Schirra, now out of his 'tired' Mercury suit and no longer required to take Grissom's seat, had arrived at the Cape Mission Control Center to be on hand to back up Gordon Cooper, the primary Capcom for the mission. Also monitoring the progress closely in mission control was the Gemini 4 prime crew of Jim McDivitt and Ed White. [32]

In the blockhouse, Tom Stafford in the 'Stoney' Capcom position communicates with the crew during pre-launch operations at the Cape. (Courtesy Ed Hengeveld)

THE LEGEND OF THE BARTON FREEway

The space program is full of great stories, larger than life characters, "gee-whiz" data and legends. Some are fantastic exaggerations, tales of space explorer lore and myth, while others are built upon tradition and truth. One of the true stories is the origin of the Barton FREEway, centered around Launch Complex 19 at the Cape, the Gemini program and the unofficial "Mayor of Pad 19," Air Force Warrant Officer (CW4) Elmer E. 'Gunner' Barton, who was also known as the "King of Pad 16." Barton was renowned for his efficiency at getting everyone working together in unity and the astronauts soon took to him. He also developed a close relationship with those who provided the spacecraft that were to launch from the Pads he was assigned to.

In 1964, Elmer Barton, who reminded the astronauts of the Phil Silvers TV character *Sergeant Bilko*, was the Facilities Engineer at Launch Complex 19. Although this was to be the primary launch pad for the Gemini missions, the astronauts still had to suit up in a temporary building next to the blockhouse of Pad 16. Even though the two pads were separated by some distance, this arrangement was far better than during the Mercury program, where the astronauts had suited up in Hanger S in the Cape's industrial area and were then transported several miles to the launch pad. Despite the proximity of the two pads, however, the journey for the Gemini astronauts still involved an indirect ride of about one mile (1.609 km) down ICBM Road in a modified parcel delivery step-van. Now fully suited in their pressure garments, the astronauts soon discovered that even this shorter journey was hot and uncomfortable in typical Florida weather. As a result, several astronauts voiced their desire for a shorter, more direct route, often directing their opinion to Barton. None did so more strongly than Gus Grissom.

Following his experiences with *Liberty Bell 7*, Grissom had developed an ill-feeling towards the press contingent and now, preparing for Gemini, he was not happy with the original route between the Pads because it went outside the perimeter fences. This put the astronauts in closer proximity to the press waiting outside than they desired, particularly Grissom.

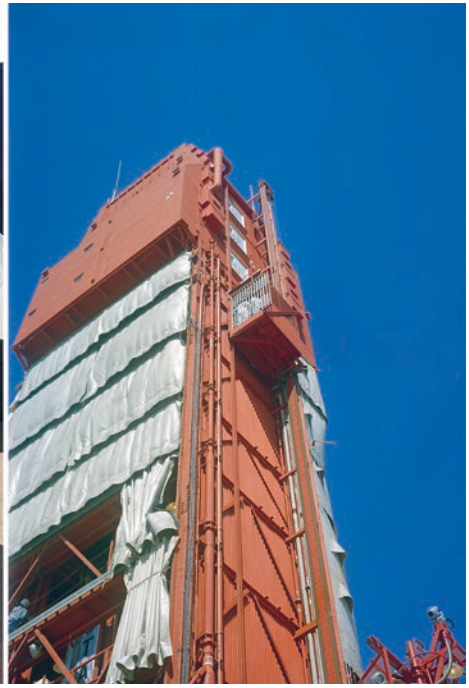
As with many desired improvements to a space program, there was little funding to initiate such a venture and a clear lack of support within the NASA hierarchy to improve the situation. However, there was an authorized plan in place to remove any scrub-brush between Pad 19 and 16 that was higher than three feet (0.9 m). This was to create a serviceable Pad Abort landing area and conform to the safety margins required by the possibility of an astronaut ejecting from a potentially exploding Titan launch vehicle. In an inspired move – and without asking for approval – Barton came up with a solution to the astronauts' problem. As the trucks full of the cut down scrub-brush needed to exit the area, he simply arranged for the perimeter fences to be relocated, creating a 'new road' on which the laden trucks could depart more easily without affecting the operations on either Pad. The fact that this new road just happened to begin right next to the Pad 16 suiting building and then doglegged north and east to intersect the Pad 19 perimeter road meant that it also created the much needed and appreciated short cut for the astronauts.

The work to create this road included filling a number of bomb craters, left over from when the U.S. Navy had used the area as a practice bombing range years before it became a launch site. Other craters had already been filled with gravel and sand, so Barton relocated some of this material for the roadbed, starting at the Pad 19 area and then moving outwards back to Pad 16, as there was also a vehicle on the test stand on '19' at the time. He asked a contractor to pour oil on top of the road to keep the dust down and then a few days later, he got the road "blacktopped."

When it was complete, Barton invited Grissom to check out the new road and the time it took between the two pads. "You never saw a man [so happy], he was just like a new person," Barton recalled in 2000. "[When Grissom] got over to the pad, he said 'Man, I don't know, but it's there. I appreciate it. You don't know how happy you've made me'." I said, "Well it's for you Gus, you and your crews." [33]

Grissom was delighted that he no longer had to run the gauntlet of the press every time they went from Pad 16 to 19. He was so impressed, he immediately went off to fetch Schirra, Young and Stafford, who were training close by, to ride down the road as well. In appreciation for this 'free gift', a number of astronauts, reportedly Grissom, Schirra and Stafford, had some special signs made which suddenly appeared at the roadside, under the cover of darkness. Their clear markings displayed, in black letters on a dark green background, '*Barton FREEway*'. The 'Free' was in capitals because it had taken no official funding to build it.

A few days later, Al Shepard informed Barton that they were unable to launch due to a violation of flight rules. Barton was amazed and confused as to the reason, until Shepard pointed out the new signs that Barton had driven past many times but had not noticed. As the signs were over the six-foot (1.8 m) height limit, Shepard said they violated flight safety rules. Baffled as to how these signs had appeared, Barton told his crew to pull them down to adhere to the safety rules, but his crew reported back that they could not move them because the signs' steel posts had been bedded in concrete. Afterwards, 'Smiling Al' Shepard laughingly told Barton, "Well, I got one on you now." The signs stayed in place for several years. [34]



[Left] Stepping off the astronaut transfer (and former parcel delivery) van, Young makes his way towards the elevator at the base of Pad 19, here during a dress rehearsal for the launch. [Right] The journey into space began with a slow ride on an elevator to join *Molly Brown* on top of the Titan booster.

> PAO Paul Haney: "Our status is green and go at this time. We had no problems on the range or here at Cape Kennedy and the status board for the individual [tracking] stations around the world is completely green. The storm that was developing off the north-west coast of Australia yesterday has shifted so it no longer poses a threat to our Carnarvon station."

The storm Haney spoke of was not the one brewing between Conrad and Hunter, but one that had not been detected prior to data being received from a Tiros weather satellite early on March 22. Meanwhile a second satellite, Syncom II, was "hovering in a figure of eight pattern," as Haney described it, over the Indian Ocean. This was a communication satellite to be used to relay signals from the *Coastal Sentry Quebec* ship, on station midway between South Africa and Australia.

With everything proceeding smoothly, Flight Director Chris Kraft approved spacecraft hatch closure earlier than the flight plan. The hatches were closed at 07:34, eleven minutes early, giving the crew more time to run through their checkout procedures. The network was then checked, with everyone reporting that they were ready. The checkout of equipment revealed that everything was in excellent shape.

On hand to witness this first live manned launch was a press contingent that topped any that had attended a Mercury flight, with nearly 1,000 news media at the press site and several thousand people lining the local public beaches to witness the launch. Special guests at the launch site included Vice President Hubert Humphrey, who was in the Control Center with Dr. Robert Seamans, the Associate Administrator for NASA, General Bernard Schriever, Commanding General of Air Force Systems Division, Dr. Ed Welch, Executive Secretary of the National Space Council, Congressman Olin Teague of Texas and many other notables.

Dr. Charles Berry reported that the biomedical data being received on both men was normal and the outlook for the weather remaining good for the important camera coverage to record the launch was optimistic. To track the launch and ascent, there was a single NASA camera located in Melbourne, Florida, 20 miles south of launch site, with another five cameras around the Cape area.

The smooth countdown was interrupted at T–38 minutes by an indication of a leak in an oxidizer line on the first stage of the Titan. On hearing this, Chris Kraft decided to hold the count at T–35 minutes to allow time to understand exactly what the problem might be. A group of pad technicians were sent out to investigate the leak and found that a nut seal on a valve on an oxidizer line pressure transducer in the launch vehicle had come loose. The problem was solved with a quick turn of a wrench by backing off the nut and gently re-torqueing it. The hold continued for another 24 minutes for observations to confirm that the repair had held and there were no further leaks. After the White Room had been secured, the team took advantage of the hold to lower the erector and prepared to pick up the count once again. On board Gemini 3, Grissom reported that everything was in readiness for the launch. Deke Slayton took this opportunity to call Gus Grissom's wife Betty directly, reporting back her reply that she was "Go" as well. He was still trying to reach Young's wife Barbara to check her status for this first launch with her husband on board (see sidebar: *Back at Home*).

BACK AT HOME

Most of the focus on any space mission, from the early days to the present, has always been on the crew and their mission, with their colleagues on the backup or support teams, or the hundreds of support workers and flight controllers rarely becoming the focus of media attention. But there has always been another group of people who are integral to each mission and the crew members chosen to fly them: the families of each of the prime crew.

Stability at home is even more important when one considers the hundreds of days that crewmembers spend away on training, briefings and simulator runs, cross-country and foreign trips, or numerous public relations duties and tours. On top of this, countless hours of the time they do get to spend at home can be taken up with poring over the latest updates and documentation that are part and parcel of spaceflight training.

For the Original Seven, the first to confront the fame that came with being an astronaut celebrity, it was as challenging for the families as it was for the astronauts.

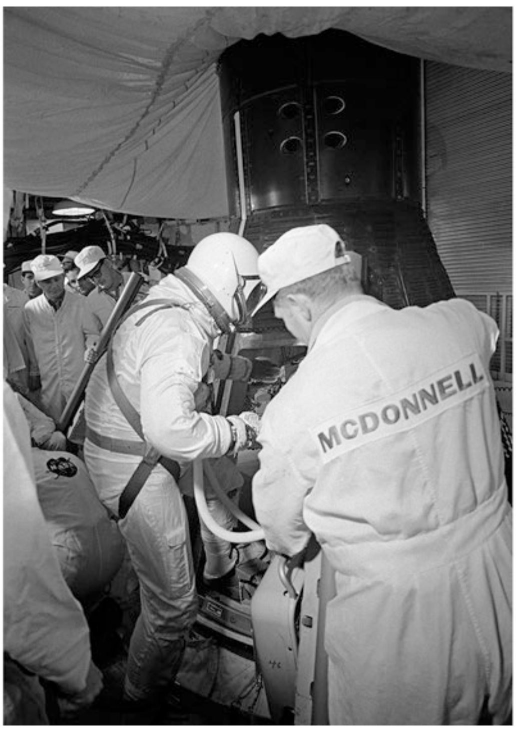
Their military background helped, as separation, loneliness and the threat of imminent danger or even death for their loved one was part and parcel of being married to a leading military jet pilot. It did not get any easier throughout the pioneering years of their NASA assignment. The nature of the risk may have changed and at least they weren't in Vietnam, but the danger was still ever present. In those early years, it seemed that NASA and the nation expected and believed that the wives of America's first astronauts were made of their own "*Right Stuff*," fully supportive of their husbands in their quest for the Moon. However, in recent years, accounts of their recollections of those times – their challenges, fears and joys – have begun to emerge, revealing very personal journeys and the sacrifices required even without leaving the family home, as their husbands strived for the Moon. It is as well that such stories are now being revealed. The development of human exploration of space has always been – and will continue to be – their journey too.

As preparations continued towards the first Gemini mission, Gus Grissom commented that some wives seemed quick to open the champagne and celebrate a successful ride into orbit (during the Mercury program). "I thought, what are you celebrating? They're not down yet. The longest minute is waiting for that orange and white parachute that could spoil the whole thing. Not until they get on that ship are they back," he often said. [35]

Grissom's wife Betty recalled in 1974 that on the day Gemini 3 was launched, she felt no special apprehension that Gus was about to be rocketed into space for a second time. She had stayed at home for the launch, as she had for his first flight on *Liberty Bell 7* four years earlier, but the TV was on and NASA had set up a direct phone line to the Cape. There was also a NASA Public Affairs Officer there to help deal with the press. The only astronaut wife with her was Gordon Cooper's wife Trudy. Most of the others had gone to the Cape to witness the launch, although Betty's two sons were home from school. Betty Grissom later wrote that she felt there was less tension this time before the flight. At launch, she applauded as *Molly Brown* climbed spaceward.

Barbara Young also remained at home in Houston for the flight, but had an uncomfortable night before the mission as her son was recovering from a bout of chickenpox. As the countdown ticked away, the phone rang. It was a special hotline so that she could hear John's voice directly from the spacecraft, but when she answered no one could hear her, so she hung up. It kept ringing, as did the doorbell because delivery people were bringing messages of good luck and bunches of flowers from well-wishers. With the phone ringing again and again, still with no one at the other end, a telephone repair man suddenly appeared (apparently from nowhere according to Barbara Young) and began working on the fault. Then, close to the lift-off time, Barbara Young reached for a pair of her son's dungarees and started sewing an old rip in them, while also trying to keep the 'Good-Luck' gift of candies out of her daughter's reach. Finally, the telephone repair man said that she might be able to talk with her husband after all, when Gemini 3 was in orbit. She soon scoffed at that idea, releasing that they would not have time to talk from space.

Meanwhile, her daughter was worried the launch would be scrubbed, but then the TV screen showed *Molly Brown* leaving the pad and Barbara Young told her children: “He’s on his way.” Her son, also called John, suddenly announced, “Daddy’s got a rocket ship, Daddy’s got a rocket ship,” as he ran around the house. Barbara Young later admitted she was not afraid of the launch but had not known what to expect. Shortly afterwards, Sue Borman and Marylyn Lovell were among the first astronauts’ wives to come by to help out, fending off the now endlessly ringing working phone. Minutes later, with Young safely in orbit, life in the astronaut’s household returned to some normality, with his daughter resuming her piano practice and his son revealing a frog he had caught in an empty coffee tin to a room full of occupants. When he released the frog, all the adults looking on played their part and dutifully acted scared. [36]



Squeezing into the tight confines of a Gemini crew compartment.

Grissom (in the foreground) and Young (at rear) in their seats inside *Molly Brown* waiting for the hatches to be closed and sealed.

At 45 minutes after the hour, the count resumed at the T–35-minute mark. At the time, Vice President Humphrey and Dr. Robert Seamans were in attendance at the Control Center, chatting with Kraft about the status of the mission and giving the whole team a message of encouragement and complete confidence in their ability to succeed at what they were about to do.

At the T–26-minute point, Chris Kraft polled flight controllers for a “GO/NO GO” status check. All came back with an emphatic “GO!” In the buildup to the launch, during the lulls between activities, Vice President Humphrey made a five-minute visit to the floor of MCC, where he chatted to Mission Director Chris Kraft, other flight controllers and astronauts Wally Schirra, Gordon Cooper and Gene Cernan before returning to the viewing area to observe the flight as the time for launch approached.

Out on the pad, Gemini 3 looked slightly different to GT-1 or 2. It had stripes on the outside of the spacecraft, added to raise temperatures slightly in the Adapter Section that housed the major systems (maneuvering fuel, the ECS, water boiler, batteries, radiators and other major items). Temperatures varied from point to point around the lower end of the Adapter Section and would be recorded as low as 100 degrees below zero once in space.

To check the re-entry control systems onboard the spacecraft, the propulsion rings on each of the thrusters were briefly 'blipped' for 20 milliseconds, as were all 16 thrusters on the 'B' ring. Spacecraft Test Director George Page worked directly with Grissom to complete these tests. Meanwhile, the checkout of all the cockpit switches to ensure they were in the right position continued.

> PAO Haney: "T–10 minutes and counting. A poll of controllers, flight surgeon, guidance, navigation and control, Capcom, tank pressure monitor, booster systems engineer, retro-fire officer, flight dynamics officer, guidance officer, network and electrical environmental and communications systems officer – Go… Go… GO. [The] board is green around the [worldwide] range and we are looking very good at this time. T–9 minutes, this is Gemini control."

> PAO Haney: "T–2 minutes and counting [with] cross conversation [going on] between Grissom and Young. Everything is in a 'Go' condition… T–1 minute… T–45 range holding final check… T–30 recorders to fast speed. Twenty seconds… 15 seconds… ten, nine… zero. Ignition and LIFT-OFF. We have lifted off at 24 minutes past the hour, rising very nicely, cabin pressure climbing."

Over in Australia, just prior to this historic launch, the staff at the Carnarvon station had been running through their checklists, coordinated by Operations Supervisor Dick Simons. In his 2001 account of the development of Australian space tracking stations, staff member and author Hamish Lindsey, a specialist in timing, voice communications and ranging, recalled the fledgling global space tracking network at that time. He was surprised to receive a request from the Capcom (astronaut Pete Conrad) to tune into the short-wave Voice of America station so that he could hear the launch countdown and ascent in detail and in real time, rather than the slightly delayed signal through Carnarvon's headsets via the private phone voice line called SCAMA (Switched Conference And Monitoring Arrangement) from the Cape [37].

SUMMARY

At last, Gemini 3 was airborne with two astronauts onboard.[11] It had been just under six years since Harry Goett's committee at Ames Research Center had explored the possibility of upgrading the one-man Mercury 'capsule' to perhaps a two-man spacecraft with far more capabilities. Now on its third launch, Gemini was flying with a crew, but it had been a challenging seventy months that had required the establishment of an upgraded tracking and communication network, the man-rating of a former ballistic missile and the development of essentially a brand new spacecraft. Some of the ideas had worked well, such as the modularization of equipment; others took longer to develop, such as the ejection seat system qualification and certifying Titan to carry humans; and some fell by the wayside, such as the proposed land-landing Rogallo Wing program. But on March 23, 1965, every-

[11] Gemini 3 had left behind a clean pad with minimal damage, much less than on Gemini 2's launch two months earlier, indicating that a rapid turnaround on the pad was feasible to ensure the shortest possible time between future launches.

thing came together. As the clock counted up for Gemini 3, it also ticked closer to President Kennedy's deadline for Apollo, so there was a lot riding on that launch of *Molly Brown* and the two astronauts sitting inside the spacecraft. Grissom, the veteran Command Pilot, would very soon become the first person to fly into space twice, while Young, the rookie Pilot, was embarking on the start of what would become a remarkable career in space. Both men had followed very different paths to this convergence of their lives and careers.

References

1. NASA MSC News Release 63-242, November 21, 1963.
2. New York Times, November 24, 1963, p. E1.
3. **Failure Is Not an Option**, Gene Kranz, Simon & Schuster, 2000 p. 122
4. **Starfall**, Betty Grissom and Henry Still, 1974, pp. 131-132.
5. New York Times, November 24, 1963, p. 2.
6. William Hines, Washington Sunday Star, November 24, 1963.
7. Washington Post, Associated Press, November 29, 1963.
8. NASA MSC Release 63-11.
9. **Gemini: Steps to the Moon**, David J. Shayler, Springer-Praxis, 2001, pp. 100-108
10. **Project Mercury, NASA's First Manned Space Programme**, John Catchpole, Springer-Praxis, 2001; **Friendship 7, The Epic Orbital Flight of John H. Glenn Jr.**, Colin Burgess, Springer-Praxis 2005; and **Aurora 7, The Mercury Space Flight of M. Scott Carpenter**, Colin Burgess, Springer-Praxis, 2016.
11. **On the Shoulders of Titans**, A History of Project Gemini, Barton C. Hacker and James M. Grimwood, NASA SP-4203, 1977, pp. 219-231
12. Undated document in the archives of the BIS, but probably originating from the meeting of the MSC Experiment Board on January 16, 1964.
13. **Forever Young: A Life of Adventure in Air and Space**, John W. Young with James Hansen, University Press of Florida, 2012, p. 74.
14. *Gemini Spacecraft 3 Tested in Altitude Chamber*, MSC Space News Roundup, Vol 4, No. 3, November 25, 1964, p. 8
15. Gemini 3 Mission Report, Part 7, Section 7.1.1.4 *Training*, pp. 7-7 to 7.9.
16. Project Gemini: A Technical Summary, p.173
17. Gemini 3 Mission Report, MSC-G-R-65-2, NASA, April 1965, Section 7.2 Aeromedical pp. 7-28 through 7-35
18. Information courtesy Manfred 'Dutch' von. Ehrenfried, via email, February 26, 2017.
19. **The Rocket Men**, Rex Hall and David J. Shayler, Springer Praxis 2001, pp. 251-262
20. NASA News Release 65-93, March 19, 1965.
21. **Go Flight, The Unsung Heroes of Mission Control, 1965-1992**, Rick Houston and Milt Heflin, Nebraska University Press, 2015, p. 58
22. Aviation Week and Space Technology, Editorial, Robert Holtz, March 22, 1965, p. 11.
23. Washington Daily News, Editorial, Samuel Lubell, March 22, 1965.
24. **Tracking Apollo to the Moon**, Hamish Lindsay, Springer-Verlag, 2001, p. 98.
25. Reference 3, pp. 126-131
26. FAA Release 65-21, March 22, 1965.
27. Gemini-Titan 3 Press Kit, NASA Release No. 65-81, March 17, 1965, pp. 41-42.

28. **Spacesuit Development and Qualification for Project Gemini**, James Barron II, December 2012, NASA US Spacesuit Knowledge Capture Series.
29. **U.S. Spacesuits**, Kenneth S. Thomas and Harold J. McMann, 2nd edition, Springer-Praxis, 2012, pp. 61-67 and 420-421.
30. NASA JSC Oral History Project, Joe Schmitt, 1998.
31. **Gemini!** Virgil ‘Gus’ Grissom, Macmillan, 1968, p. 104
32. Reference 31, p. 106
33. Elmer E. Barton, NASA JSC Oral History Project, April 12, 2000
34. Reference 31, pp. 104-106; also, Air Force Space and Missile Museum, Cape Canaveral, Florida on line website www.afspacemuseum.org, last accessed August 2017
35. Reference 4, p. 150
36. *He’s on his way…and it couldn’t be prettier*, Miguel Acoca, in *Gemini’s Journey*, Life Magazine, April 2, 1965 pp. 34-42
37. Reference 24, pp. 98-100

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Gus and John

> *"Until we joined up for this flight, I didn't know John Young any better than any of the others in their group. By launch time, John and I will know each other pretty well."*
> Gus Grissom, quoted in *Starfall* (1974)

Gus Grissom might not have known much about his pilot John Young prior to their formal assignment together as the prime crew of Gemini 3, but he certainly recognized that all of the second group of astronauts selected in September 1962 were very talented individuals, even suggesting that they might be smarter than his own group of seven Mercury astronauts, the first chosen by NASA in April 1959.

There were a few similarities between the two of them, as the press reports of the day liked to point out. Young stood five-feet nine inches (1.78 m) tall and weighed 160 lbs. (72.57 kg), two inches (5 cm) taller and ten pounds (4.53 kg) heavier than Grissom. Both had brown hair, though the color of their eyes was different; Grissom's were brown but Young's were green. Both were married, with two children each. Though most of the physical description was irrelevant to many, the size and weight of each astronaut certainly played a part in selecting crewmembers for the tight confines of the Gemini spacecraft, to allow them to fit, fully suited, without too much difficulty.

Naturally, there were also distinct differences between the two men. Grissom had celebrated his 38th birthday on April 3, 1964, ten days prior to being named to command Gemini 3, while his pilot was four years younger. Grissom was major in the USAF, while Young was a lieutenant-commander in the U.S. Navy. Grissom had over 4,000 hours flying time which included in excess of 3,000 hours in jets, while Young had over 3,000 hours flying time and over 2,500 hours in jets. Off duty, these family men also enjoyed a range of sports. Grissom's hobbies were cited as fishing and boating, with skiing and hunting included. Young enjoyed swimming, water skiing and physical fitness exercises. He liked to run to stay fit and enjoyed playing one of the astronaut group's favorite sports – handball – though he was not as good as Grissom who, it was said, was the best in the office.

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_5

VIRGIL IVAN 'GUS' GRISSOM, COMMAND PILOT GEMINI 3

Much has been written about the life of Command Pilot of Gemini 3. Sadly, most of it has focused upon his untimely death in the Apollo 1 pad fire of January 27, 1967, but his involvement in the Gemini program was the longest assignment in his astronaut career. He even penned his own account of his involvement in the program, which was published after his death. As one of the first seven American astronauts, he shot to fame from the moment he was chosen to fly on the Mercury spacecraft by NASA in April 1959. However, he would not become the first man in space, an honor that went to Soviet cosmonaut Yuri Gagarin. Nor would he be the first American astronaut to fly into space, an honor that went to Al Shepard. The title of first to spend a day in space went to another Soviet cosmonaut, Gherman Titov and the title of first American to orbit Earth went to John Glenn. No, Gus Grissom would make his mark in space exploration history by flying between these four pioneers of spaceflight. He was the second American to fly in space, on another suborbital mission, as the solo pilot of Mercury Redstone 4 *Liberty Bell 7*. Unfortunately, that mission is mostly remembered for the near-disaster of the mission's end, in which Grissom almost drowned during the recovery barely 15 minutes after leaving the launch pad and the empty capsule was lost to the ocean depths for 38 years (until it was recovered in 1999). [1] Grissom's pride might have been dented in the aftermath of *Liberty Bell 7*, but he was subsequently honored by being the first man to *return* to space as Command Pilot of Gemini 3 and he would later secure the Commander's seat for the first manned Apollo.

He could have achieved so much more, had fate not intervened with the tragic and horrendous end to this remarkable man. He lost his life less than two years after flying Gemini 3, in the disastrous Apollo 1 pad fire at Pad 34 at Cape Kennedy, along with Ed White and Roger Chaffee. That single event remains a deep scar in American human spaceflight history and generated most of the accounts of Grissom's short life and achievements. More recently, a new book has revisited the story of a man who remains one of the icons of the early manned space program.[1]

Early years

Virgil Ivan 'Gus' Grissom was born on April 3, 1926, in the southern Indiana town of Mitchell. From 1940, he attended Mitchell High School, graduating in 1944.[2] Grissom had a news round in order to earn a little pocket money, delivering the papers twice a day. He supplemented this during the summer months by being hired by local farmers to pick cherries

[1] Those books of note about Grissom include *Gemini*, by Grissom himself (published posthumously in 1968); *Seven Minus One* by Carl L. Chappell (1968); *Starfall,* by Grissom's widow Betty and Henry Still, (1974); *Gus Grissom, Lost Astronaut* by Ray E. Boomhower (2004) and *Calculated Risk, The Supersonic Life and Times of Gus Grissom*, by George Leopold (2016). A detailed account of Grissom's early life is included in *Liberty Bell 7, The Suborbital Mercury Flight of Vigil I. Grissom*, Colin Burgess, Springer-Praxis, 2014, specifically Chapter 2, *An Astronaut Named Gus* pp. 55-66.

[2] According to Betty Grissom in Starfall (1974), Grissom's nickname came from an acquaintance, who had read his abbreviated name 'Gris' upside down on a card game scorecard and mistakenly thought it read 'Gus'. The name stuck.

Grissom with his proud parents, at the Cape on March 25, 1965, following the completion of the Gemini 3 mission. At left is his mother Mrs. Cecile Grissom and at right is his father Mr. Dennis Grissom. (Courtesy Ed Hengeveld)

and peaches from their orchards. Following the bombing of Pearl Harbor in December 1941, America entered the Second World War and in 1943, now a 17-year-old High School senior and determined to become a military pilot, Grissom enlisted in the U.S. Army Air Corps.

A flying ambition

On August 8, 1944, shortly after graduation from high school, Grissom was inducted into the Army Air Force at Fort Benjamin Harrison, as an Army Air Corps Aviation Cadet. He then completed five weeks of basic training at Sheppard Air Force Base (AFB) at Wichita Falls, Texas, where he remained hopeful of becoming a pilot and flying combat missions in WWII. Unfortunately, he was assigned as an office clerk with the rank of Corporal at Brooks Field, San Antonio when he completed the training course, instead of heading off to flying school. This was also in Texas, a state where he would come to spend a lot of time during his life. With the end of hostilities in Europe in May 1945 and the Japanese surrender three months later, flying opportunities for young pilots were inevitably reduced.

In November 1945, therefore, with little prospect of progressing with a flying career, Grissom decided to leave the military and took a temporary job installing doors on school buses at the Carpenter Body Works back home in Mitchell, Indiana. The work was repetitive and mundane and deep down, this future astronaut knew that this was not something he wanted to do for the rest of his career. Instead, he decided to become a mechanical engineer and enrolled under the G.I. Bill as a student on the mechanical engineering course at Purdue University, Indiana, in September 1946.[3] Grissom typically worked hard and graduated in February 1950, a full semester early, earning a Bachelor of Science degree in Mechanical Engineering.

By now, he had married and had started a family. Grissom had met his future wife, Betty Lavonne Moore, at Mitchell High School and they married on July 6, 1945 while he was on leave from the Army Air Force. They were both still teenagers. Their first son was born in May 1950, followed by their second son in December 1954. With a growing family to support, Grissom worked a variety of part time jobs to supplement his income in addition to attending college at Purdue and studying. These included thirty hours a week flipping burgers in a local diner, or working as a night-time telephone operator.

Upon graduation from Purdue, Grissom had to decide the path of his future career. At first, he tried to secure a position in engineering, including at a brewery, but he soon realized that his heart was in aviation and decided to re-enlist. By now, the Army Air Corps that had emerged from the Second World War had become the United States Air Force (USAF) in its own right.

In March 1950, Grissom re-joined military service, this time as a USAF aviation cadet. He was assigned to Texas again for his basic training, this time at Randolph AFB. In September 1950, he graduated basic training and was assigned to advanced pilot training at Williams AFB, Arizona. This was followed by aerial gunnery training at Luke AFB, also in Arizona. In March 1951, Grissom finally graduated from pilot training, received his wings and was commissioned as a second lieutenant in the USAF.

Grissom's first assignment took him to Presque Isle AFB in Maine, where he served as a North American F-86 *Sabre* pilot with the 75th Fighter Interceptor Squadron until December of that year. This included a temporary squadron assignment to Dover in Delaware.

Combat and test pilot flying

Grissom had wanted to serve his country and fly combat missions in WWII, but although he had joined up in time, he had been too late to see action in that conflict. Five years later, a new conflict was developing, this time in the Korean peninsula. Following WWII, in an agreement with the United States, the Korean peninsula north of the 38th parallel had been liberated from the Japanese by the Soviet Union. By 1948, relations between the two nations were deteriorating and developed into what became known as the Cold War. Essentially, this was a political hostility between the United States and the Soviet Union,

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[3] The G.I Bill, also known as the Servicemen's Readjustment Act of June 22, 1944, was a law which provided for WWII veterans and featured a range of benefits, including funds for tuition and living expenses to attend higher education.

[Left] Grissom during his test pilot days at Edwards AFB, California. [Right] A formal portrait of Virgil I ‘Gus’ Grissom, USAF. (Images courtesy USAF)

highlighted by threats and propaganda but falling short of open warfare, though it came close on several occasions. As a result, the Korean peninsula was split into two separate regions with separate governments. In the north, the communist regime was supported by the Soviets and China, while in the south, a capitalist leadership was supported by the United States. The problem was that neither side recognized the border. By June 1950, things had deteriorated rapidly, to the point where North Korean forces moved into the south. Consequently, the United Nations sent a UN force, mostly provided by the United States, to repel the invasion. Then, in October 1950, a massive Chinese force crossed the Yalu River on the border with North Korea and entered the war, escalating the conflict for the next three years.

In December 1951, a decade after America’s decision to enter the Second World War had inspired the young Gus Grissom to dream of a career as a fighter pilot, the now 25-year-old USAF aviator found himself reassigned as a North American F-86 *Sabre* replacement pilot, traveling to Korea to join the 334th Fighter Interceptor Squadron, part of the 4th Fighter Interceptor Wing assigned to Kimpo, South Korea. Three months later, his squadron was reassigned to Suwon, where he flew a number of aerial patrols. In total, Grissom would fly 100 combat missions. However, his request to remain in Korea to fly another 25 missions was refused and in June 1952, now a first lieutenant and decorated with a Distinguished Flying Cross and the Air Medal with cluster, Grissom returned to the United States to be assigned to Craig AFB, in Alabama. There, he attended Flight Instructor School, because the air force wanted to utilize his experiences in Korea to instruct new pilots. Following graduation, Grissom was assigned to Bryan AFB, back in Texas once more, as a jet instructor pilot for the next three years.

In August 1955, Grissom began his higher education, studying aeronautical engineering at the USAF Institute of Technology (AFIT) located at Wright-Patterson AFB, in Dayton, Ohio. On June 23, 1956, he survived a crash of a Lockheed T-33 *Shooting Star* following take off from Lowry Field, Denver. He was co-pilot with future fellow Mercury astronaut Leroy Gordon ('Gordo') Cooper. The aircraft suffered a loss of power, struck the runway, skidded and burst into flames, but neither man suffered injuries.

In October 1956, Grissom was selected to attend Class 56D at the USAF Test Pilot School at the famed Edwards AFB in California, from which he graduated in May 1957 and was promoted to captain. He then returned to Wright-Patterson as a test pilot in the fighter branch there. It was here, as Grissom later recalled, that he felt "there wasn't a happier pilot in the air force."

The Original Mercury 7 in an informal pose. Left to right: Gordon Cooper, Wally Schirra (partially hidden behind Cooper), Al Shepard, Gus Grissom, John Glenn, Deke Slayton and Scott Carpenter.

One of just seven

On April 9, 1959 and very much to his surprise, Grissom was named as one of the country's first seven astronauts, chosen to pilot the Mercury space capsule. On April 27, the group reported to NASA's Space Task Group at the Langley Research Center, Langley Field, in Hampton, Virginia, for Mercury training. His selection always amazed Grissom, as he thought the other candidates were all more highly experienced.

The quest to be the first man in space, not just the first American, meant long hours for each of the seven astronauts. Frequently logging sixteen-hour days, travelling across the length and breadth of the continental United States was both demanding and challenging even for a military test pilot, but it was enduring the unfamiliar attention of the media and the public that the normally reserved Grissom was never comfortable with. During that first year at NASA, Grissom and his wife calculated that he had spent 305 out of 365 days away from home and it was only to get tougher.

Such was the complexity of the Mercury program that in July 1959, each of the seven astronauts was allocated a technical assignment. For Grissom, this was in the automated and manual control systems of the spacecraft, an assignment that would later stand him in good stead during the early years he would work on Gemini.

Quest to be first

Initially, the idea was that each of the seven astronauts would be launched on suborbital trajectories on the Redstone booster, before conducting orbital flights launched by the Atlas booster. This was subsequently amended to just two manned sub-orbital Redstone flights and initially five orbital manned Atlas missions, though only four were actually flown. The training and competition between the seven men was intense for that coveted first seat into space. On January 19, 1961, hoping like all of his colleagues that he would be the one to get the nod as America's first man in space, Grissom was informed by Robert Gilruth that he would instead be flying the second suborbital mission, with John Glenn as his backup. On February 21, Grissom was officially nominated, together with Al Shepard and John Glenn, to commence "special training" for the first Mercury mission, MR-3, knowing that Shepard had been selected for the chance to be the first man in space (but not orbit). On April 12, 1961, however, the Soviets dealt another huge propaganda blow to American plans when they launched Yuri Gagarin onboard Vostok, not on a suborbital lob, but around the world for a single orbit.

Liberty Bell 7

After the humiliation of the disastrous Bay of Pigs fiasco in Cuba, the hammer blow of Yuri Gagarin's flight and the eventual success of Shepard's brief suborbital mission aboard *Freedom 7* on May 5, 1961, President John F. Kennedy wanted to know how America could gain the lead in space exploration from the Soviets. After much deliberation, he announced on May 25, 1961 that America would put a man on the Moon and return him safely to Earth before the end of that decade. The arms race of the Cold War that had developed into a space race had now become an all-out race for the Moon to demonstrate which superpower – and which ethos – was the most advanced. Less than two months later, Grissom found himself strapped inside the Mercury 4 capsule on top of a Redstone rocket pointed towards space. Each of the Mercury astronauts had decided to name their own spacecraft and added the '7' in recognition of the very special fraternity of their

July 21, 1961. Grissom is lifted from the ocean following the splashdown of *Liberty Bell 7*. [Inset] Grissom in July 1961, wearing his Mercury pressure garment, holding his portable suit air conditioning unit and standing by to climb aboard *Liberty Bell 7*.

group. As the spacecraft resembled a 'bell' shape, Grissom decided to name his Mercury 4 capsule *Liberty Bell 7* and this was painted on the side of the capsule. Then one of the engineers came up with the bright idea that there should be a crack painted on it, just like the real Liberty Bell. However, no one really knew what the crack looked like, until someone noticed that it appeared in the image found on the back of a fifty-cent coin. With no better reference available, they copied that.

On July 21, 1961, after two previous attempts had been aborted due to the weather, Grissom was launched into space on his 15-minute suborbital trajectory down the Atlantic Missile Range. He became the third man and the second American in space, though Gagarin remained the only one to have reached orbit at that point. The recovery phase of his mission has been well documented in other publications over the years, but briefly, Grissom might easily have drowned after splashdown as he struggled free of *Liberty Bell 7*, which had begun to sink because the hatch had blown prematurely and was allowing sea water to enter the capsule. As the helicopter pilots attempted to lift the water-laden capsule, Grissom struggled to stay afloat and could have drowned as his suit began to fill with water. Fortunately, he had raised his neck dam, thus preventing more water from entering the suit. Grissom was rescued by a second helicopter, but his capsule was lost and remained submerged for 38 years.[4] After the mission, Grissom praised the work of Wally Schirra in helping to develop the neck dam that was designed to prevent sea-water from breaching the neckline of the suit.

Point of Contact for Mercury Mark II

Following his Mercury assignment, Grissom became the Astronaut Office representative to determine crew positions and display parameters for the new Mercury Mark II spacecraft, an improved and expanded Mercury design intended for two astronauts.

In this 1962 image, Grissom sits onboard the Parasev (PAraglider RESEarch Vehicle), which he would test-fly, at the Flight Research Center, California. Gemini was initially planned to have a paraglider land-landing capability but this was abandoned prior to flight operations in favor of an ocean splashdown. (Courtesy Ed Hengeveld)

[4] On July 20, 1999, thirty years after Apollo 11 landed on the Moon and almost 38 years to the day after it sank, Grissom's capsule was finally pulled from the ocean bed after a 14-year search to locate it. Liberty Bell 7, the capsule that NASA had initially lost, had been finally recovered thanks to Curt Newport and the Kanasas Cosmosphere and Space Center.

Throughout 1962, Grissom continued to work with McDonnell engineers to develop the Gemini spacecraft's crew compartment layout, while also supporting his fellow Mercury astronauts on their own orbital missions. In February of that year, he was Bermuda Capcom for John Glenn's historic three orbits in *Friendship 7* and then in May he was at the Capcom console again, this time at Mission Control at the Cape in Florida for Scott Carpenter's three-orbit flight in *Aurora 7*. In July 1962, Grissom was promoted to the rank of major in the USAF and that October he once again served as a Capcom, this time in Hawaii for Wally Schirra's *Sigma 7* flight.

Later that October, Grissom became the 'training manager' for the second group of astronauts, which included John Young and Tom Stafford. During 1962, the 'Astronaut Office' had been relocated from the Langley facility to the new Manned Spacecraft Center near Houston, Texas, although for the first few weeks most of their work was done out of rented offices in downtown Houston.

On to Gemini

The start of 1963 was a time of change for NASA and its manned spaceflight program. On January 26, the astronaut group, now expanded to sixteen with the nine new Group 2 candidates, received new technical assignments. For Grissom, these included continuing his role as the Astronaut Office point of contact for Project Gemini, as the former Mercury Mark II was now known. He completed his fourth tour as Capcom in May 1963, this time stationed out at Guaymas for the final Mercury flight of Gordon Cooper in *Faith 7*.

In July 1963, Grissom was informed by Deke Slayton that he was going to be assigned as backup Command Pilot to Al Shepard on the first manned Gemini flight, the three-orbit Gemini 3 mission. He would then be rotated to Command Gemini 6, with Frank Borman as his Pilot. At the time, Gemini 6 was penciled in as the 14-day space marathon, a mission for which Grissom's knowledge of Gemini systems would be most suited. However, he and Borman proved not to be a good match and it became clear the two men did not get on, so having them fly in close quarters for two weeks was obviously not going to work. Everything changed in October when Shepard was grounded with his inner ear ailment. With Grissom unable to work with Borman, Slayton instead assigned John Young from Group 2 to join Grissom on the first Gemini into space. They would then use their experience to reciprocate back up duties for Schirra and Stafford when they flew Gemini 6, which was now planned as the first rendezvous and docking mission. After his Gemini 6 duties, Grissom would then be reassigned to Apollo, taking the command of the first Block 1 mission, a 14-day shakedown flight in Earth orbit. Alongside his Gemini training, Grissom would also need to keep up to speed with the latest developments in the Apollo program.

By 1964, Grissom and Young were deep into Gemini mission training and were formally assigned to Gemini 3 that April. Then, on July 8, Grissom was named the Chief of the newly created Gemini Branch within the Astronaut Office, although most of his time over the next year would be taken up by preparations for the first ride on Gemini alongside his rookie pilot.

Gus Grissom pioneered the astronaut involvement in the Gemini program, so much so that the early design of the crew compartment layout was modeled around him. However, it was found to be too small for some of his colleagues and had to be adjusted.

JOHN WATTS YOUNG, PILOT GEMINI 3

It is difficult to be chosen to train as a space explorer, regardless of nationality. The credentials required and the selection process are arduous and challenging. Even after selection, the missions and opportunities to fly are few and far between, with months, or more often years between spaceflights. Some lucky few get to fly more than once, perhaps three or four times but rarely more than five. To date, only three men have experienced a rocket launch into space seven times. In recent years, astronauts Jerry L. Ross and Franklin R. Chang Díaz each flew on seven separate Shuttle missions between 1985 and 2002. Before them, veteran astronaut John Watts Young also had seven rocket launches in his log book, between 1965 and 1983, with some not-so-small differences. Unlike Ross and Chang Díaz, who flew all their missions on the Shuttle, two of Young's missions were during the Gemini program, two during Apollo and two aboard the Shuttle. Then there was his seventh rocket launch. This one, in April 1972, was from the surface of the Moon during Apollo 16. This iconic space explorer, chosen in the second group of astronauts in September 1962, last flew in space in December 1983, but he did not "hang up his spacesuit" until December 2004 – an astonishing 42 years after first being selected for astronaut training. John Young became a legend in space exploration, but it all started with him flying as Pilot on Gemini 3. [2]

John Young in naval uniform. (NASA/USN)

A "rambling wreck from Georgia Tech"

The future first Gemini pilot was born in San Francisco, California, on September 24, 1930, but was raised on the other side of the country in Orlando, Florida, as his father searched for employment during the difficult years of the Great Depression. John Young's formal education was completed in that city, where he attended the Princeton Elementary (he was remembered as a rather retiring student, well liked but never one to push himself forward), Memorial Junior High and Orlando Senior High Schools, graduating from High School in June 1948. Three months later, Young continued his education at the Georgia Institute of Technology, where he studied aeronautical engineering under the Reserve Officer Training Corps program and earned his Bachelor of Science degree in 1952.

Member of the Black and Brown Shoe Navy

In June 1952, Young enlisted in the U.S. Navy as an ensign. He had intended to apply for flight training as a naval aviator, but was instead assigned to serve aboard a ship. Between June 1952, (the same month Grissom returned from Korea) and May 1953, Ensign Young served aboard the destroyer USS *Laws* (DD-558), during which he served in the Korean conflict. Young fulfilled a number of positions on board the *Laws*, including being assistant to the gunnery officer, a division officer, a fire control officer, torpedo control officer and officer of the deck. Years later, he was the subject of many jests about his days onboard ship in the surface fleet, known as the “black shoe navy,” from those who were naval aviators of the “brown shoe navy.”[5]

In May 1953, Young finally received orders to report to flight school at the Naval Basic Air Training Command in Pensacola, Florida. After completing preliminary pilot training, he began a helicopter training course that November, resuming his fixed wing course in January 1954 after qualification. In June 1954 he completed basic training, which was followed by a six-month detachment at the Navy’s Advanced Training Station located at Corpus Christi, Texas. In December 1954, upon completion of that course as a lieutenant, junior grade, he was designated a naval aviator and awarded his Wings of Gold.

Naval aviator deployments

Following flight school, Young was assigned to Fighter Squadron (VF) 103, based at the Naval Air Station (NAS) Cecil Field in Jacksonville, Florida, where he flew the Grumman F-9 *Cougar* and Vought F-8 *Crusader* for the next four years. During the summer of 1955, his unit spent a month at Cuba’s Leeward Point at Guantanamo Bay where he flew 114 gunnery practice missions, before returning to Cecil Field for field carrier landings and carrier qualification, which required at least six landings on the carrier USS *Lake Champlain* (CVA-39). That same summer, at a beach party on Jacksonville Beach near NAS Mayport, he met his future wife, Barbara White of Savannah, Georgia. They were married in December 1955 and would go on to have two children, a daughter born in July 1957 and a son in January 1959.

Young also completed two deployments during his time with VF-103. The first was between August 1956 and February 1957 aboard the USS *Coral Sea* (CVA-43), which was deployed to the Mediterranean as part of the Sixth Fleet’s Air Group 10. The second deployment was completed between September 1958 and January 1959 aboard the USS *Forrestal* (CVA-59), also deployed to the Mediterranean with the Sixth Fleet.

Test pilot

In February 1959, Young was assigned as a student to the Naval Air Test Center in Patuxent River, Maryland, as a member of Class 22. When he graduated in November 1959 he was second in his class, but despite expressing his desire to be assigned to the Flight Test Division there, he was instead assigned to the Armament Test Division – which was renamed the Weapons Test Division in June 1960. For the next three years, he was involved in a number of test programs. In one test evaluating air-to-air missiles he was engaged with another pilot, approaching head-on at Mach 3. At such close quarters, any miscalculation could have resulted in an expensive and tragic accident. For Young and the other pilot this did not seem a major issue and both landed safely, but later Young was cautioned by the Chief of Naval Operations, asking him not to repeat the maneuver in the future.

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[5] In 1911, six naval officers were chosen from the surface fleet as the first Naval aviation trainees. At the time, the uniform footwear of sailors was black shoes, which was logical on the coal-burning ships at this time. On the land-based airfields, the new aviation students soon discovered that the constant requirement to remove the brown dust from their black shoes was a problem. As a practical solution they purchased, at their own expense, brown high-top shoes and leggings. Two years later, after much debate, the Navy Bureau adopted the brown shoes and leggings as the permanent uniform of Naval Aerial Aviators, which remained in force until July 1976.

Project High Jump pilots, left to right: Lt. Col. William McGraw USMC, Cmdr. Dave Longton USN, Cmdr. Delbert Nordberg USN and Lt. Cmdr. John W. Young USN. (US Navy photo dated February 27, 1962 – AIS collection). [Inset] Project High Jump F-4 – John Young on board the record setting F4H-1 BU-No. 149426 April 3, 1962. (U.S. Navy photo)

PROJECT 'HIGH JUMP'

On March 3, 1962, eleven days after becoming America's first and the world's third man to orbit the Earth, John Glenn received a hometown welcome in New Concord, Ohio. On the same day, the U.S. Navy filed 'time-to-climb' record claims with the Fédération Aéronautique Internationale (FAI) for the McDonnell Douglas F4H *Phantom II* fighter aircraft. These records, set over the previous month, in the 3,000, 6,000, 9,000, 12,000 and 15,000 m class (9,842 ft., 19,685 ft., 29,527 ft., 39,370 ft., and 49,212 ft.) surpassed those held by the USAF Lockheed F-104 *Starfighter* since 1958 and bettered those made by the USAF T-38 *Talon* trainer on February 19, 1962. One of the Navy pilots who set those new records was 31-year-old Lt. Commander John W. Young.

While assigned to the Naval Air Test Center for three years, Young had evaluated the weapon systems in the F8D and F4B variants of the aircraft. One of his fellow navy pilots and the program manager for many of the inspection and survey trials was future fellow astronaut James A. Lovell Jr.

On February 21, the day after John Glenn flew *Friendship 7* into the history books, in temperatures of 8 degrees F (-13 degrees C), John Young climbed into his *Phantom II* at NAS Brunswick, Maine and set the new record of 34.523 seconds for reaching an altitude of 3,000 m (9,843 ft.). His aircraft had been restrained by a catapult holdback bolt on the runway as it burned fuel to increase thrust, before being released to accelerate down the runway and then climb at a sixty-degree angle, accelerating to 400 knots (460.31 mph or 740.79 kph). He attained a peak altitude of 3,048 m (10,000 ft.) before returning to the airfield, his aircraft traveling so fast that the range trackers found it difficult to keep up with him. After the flight, Young commented "It's not like flying as much as it is like riding a rocket," an ironic bit of foresight, considering what he would be experiencing first-hand barely three years later.

The F-4, under classified restrictions, was already demonstrating that it had a significant flexibility in delivering ordnance and had displayed great capabilities during supersonic high-altitude tests, underlining its potential as a front line interceptor. In addition to its service with the USN, the *Phantom* was in line to be put into USAF service as the F-110. The series of High Jump 'time-to-climb' records were linked to those tests, though they were openly certified at the time. In all, there were eight records to be set. Those between 3,000 and 15,000 m (9,843 – 49,212 ft.) were to be attempted on the east coast out of NAS Brunswick, in the middle of winter because the cold weather there would assist in the thrust performance of the aircraft's engines and enable the *Phantom* to reach the required altitudes quickly. The record attempts at 20,000, 25,000 and 30,000 m (65,616 ft., 82,020 ft. and 98,425 ft.) were to be conducted on the west coast at NAS Point Mugu, Ventura County, in Southern California, where the high-altitude jet stream would be used to enhance the aircraft's rate of climb to the target altitudes.

At the time of his assignment to the High Jump program by the authorities at Patuxent River, Young was the junior rating of the group, which included Commander Francis T. Brown, USN, Commander David.M. Longron, USN, Lt. Colonel William.C. McGraw Jr., USMC, and Lt. Commander Delbert.W. Nordberg, USN. During the preparations for the flight, Young assisted in setting up the tracking systems at both locations. The aircraft were significantly modified to help achieve the records, with the removal of the weapon systems, replacement of non-critical surfaces with balsa wood (including the speed brakes) and the removal of a number of instruments including the navigational equipment. The afterburners were improved and additional fuel was loaded on board, with each plane flying the attempt having just the pilot onboard as another weight-saving measure. In his first practice run, Young managed to set a world speed record for an F-4 with its landing gear down of 340 knots (391.2 mph or 629.57 kph).

Young would get the opportunity to put his name in the record books a second time on April 3, when he flew his *Phantom II* (Bureau of Aeronautics serial number 149449) from the runway to 25,000 m (82,021 ft.) in 3 minutes 50.44 seconds, setting his second and the aircraft's seventh 'time-to-climb' record. Wearing a navy Mark IV pressure suit for the high-altitude flight, Young had flown from Runway 21 at Point Magu, California, the same runway that the USAF had used to set its 'time-to-climb' records in the Lockheed F-104A *Starfighter* in 1958. The tests were completed within the restricted air space of the Pacific Missile Test Range, to ensure the highest safety levels and no interference with scheduled civilian air traffic. [3] The pilots knew from experience that the plan to accelerate to Mach 1.8 and then pull up to gain altitude assisted by the jetstream would cause the aircraft's engine to over speed. Therefore, as they surpassed 60,000 ft. (18,288 m) and having gained sufficient speed to attain the new record, the engine of the *Phantom* was shut down. John Young's second record-breaking flight peaked at 82,200 ft. (25,054 m) traveling at Mach 0.74 and as he dropped back into the denser layers of the atmosphere, he relit the engines for a safe landing at Edwards AFB.

As a pilot in Project High Jump, Young had set 21 FAI records and, at the time of writing (2017), still retained three of them over 55 years later. In May 1962, Young and his fellow pilots received the Navy's Distinguished Flying Cross for their achievements in Project High Jump. In his 2012 memoir, Young stated his certainty that his work on the High Jump program "was a major factor in my consideration for astronaut selection" a few months later. [4]

Joining the "Pukin' Dogs"

Just a week after returning to Patuxent River at the completion of his High Jump assignments, Young received a new posting to VF-53 ("The Pukin' Dogs") at NAS Miramar, San Diego. Following instrument training with VA-126 ("The Bandits"), he returned to flying the F-4. The squadron was re-designated VF-143 as they fully transitioned to F-4 operations and they would later undertake seven combat deployments during the Vietnam War. Young would not be part of those deployments, however, as he was named to the second class of NASA Astronauts in September 1962, just five months after joining the squadron. When asked about his move from the USN to NASA, Young reportedly replied that he had left the best job in the Navy to take on the best job in the world. As the years passed, he often thought fondly of his time as a "Pukin' Dog," writing in 2012 "There were a lot of good people in that squadron… I never forgot about that squadron or those men. They're still with me in heart and mind today." [5]

The fate of Bu. #149449

While Young moved to Houston to commence astronaut training, the aircraft he had set his records in was returned to front line duty with the Marine Corps. *Phantom* Bu. #149449 was given the new designation F4B-11-MC and was initially assigned to VF-96 aboard the aircraft carrier USS *Ranger* (CV-61) before subsequently transitioning to VF-151 aboard the USS *Coral Sea* (CV-43).

The aircraft was eventually assigned to the Marine Air Group 13 (MAG-13) VMFA-323 "Death Rattlers," who were based at Chu Lai Air Base in the Republic of South Vietnam. On August 2, 1968, the aircraft was being flown by Major Daniel I. Carroll, USMC, assisted by Weapons Systems Officer (WSO) 1st Lieutenant R.C. Brown, USMC, when they were hit by small arms fire near An Hoa, some 17 miles southeast of Da Nang. They managed to return to Chu Lai, but discovered that the aircraft's landing gear could not be lowered. As a result, both men were forced to eject about one mile (1.6 km) off the coast, to be rescued by a U.S. Army helicopter. Unfortunately, despite her record setting pedigree, Bu. #149449 was lost in the South China Sea. [6]

NASA's Next Nine. The second group of astronauts, initially called the "Gemini astronauts." From top right clockwise: Frank Borman, John Young, Tom Stafford, Pete Conrad, Jim McDivitt, Jim Lovell, Elliott See, Ed White and Neil Armstrong, posing with a model of the Gemini spacecraft they all hoped to fly.

One of the 'Next Nine'

On September 17, 1962, Young attained even greater fame than he had as a pilot on the High Jump program when he was selected as one of nine new astronauts for NASA's Group 2, who would report for duty that October. The following day, the first photographs of the two-man Gemini mockup simulator were released by NASA and the McDonnell Aircraft Corporation. This mockup was to be used to train the new astronauts in rendezvous and docking techniques, maneuvering the spacecraft with another orbiting space vehicle. Two weeks later on October 3, the 'new nine' were on hand at the Cape in Florida to witness the launch of Wally Schirra aboard *Sigma 7*.

As their training increased, the group received their technical assignments. On January 26, 1963, John Young was assigned his technical roles in environmental control systems and personal and survival equipment. In July, Young received the news that he was to be assigned to fly with Wally Schirra as Pilot on Gemini 5, with the prospect of reassignment as backup Command Pilot for Gemini 8. If this plan did materialize, he could expect to command Gemini 11 on his second mission. By that October, however, things had changed significantly. Al Shepard had been grounded and relieved of his original assignment as

Gemini 3 Command Pilot due to his medical condition and as a result the whole Gemini crewing structure for the first few missions had to be revised. Young would now fly much sooner, with Gus Grissom on Gemini 3, without first serving on a backup crew. This was a sign of his standing in the Astronaut Office. Then the pair would backup Gemini 6, with Young then possibly rotating to command Gemini 9 while Grissom moved on to Apollo. On April 13, 1964, Young's assignment became official, as he was named to partner Grissom on Gemini 3. Three months later, on July 8, Young was assigned to the Gemini Branch in the Astronaut Office, under Branch Chief Grissom, to focus on the preparations for his first spaceflight.

Young examines a manikin dressed in a pressure suit following a 1963 parachute ejection test. (Courtesy Ed Hengeveld)

The most exciting thing

It is sometimes strange how lives become touched by a common event and then, years later, the people involved in that distant encounter cross paths once again.

During the spring of 1965, a young Navy pilot named Thomas K. ('Ken' or 'TK') Mattingly II was assigned to Heavy Attack Squadron 11 (VAH-11). He was deployed on board the carrier USS *Franklin D. Roosevelt* (CV-42), but while on shore the unit was stationed at NAS Jacksonville in Florida. On March 23, 1965, while he was at Jacksonville, Mattingly was told by a friend in the photo reconnaissance squadron there that he was about to fly down to the Cape, as he had been assigned to take pictures of the launch of "one of these Gemini rockets." He asked whether Mattingly would like to accompany him in another aircraft.

While he was happy to accept an opportunity to do something different, Mattingly was not that interested in the space program at that point: "I thought the pictures in the magazines of Mercury and Gemini weren't visually appealing," he said in an NASA interview. [7] He believed that aircraft should be elegant and smooth: "I couldn't imagine how anybody could be interested in that [space program]. It just had no appeal."

Mattingly recalled that in the mid-1960s, it was possible to do far more than it would be in more recent times (circa 2001), which included being able to commandeer a plane to fly down and watch a space launch from a unique vantage point. Having successfully obtained a plane to fly at short notice, he received the radio frequencies to be used during the launch and flew down to the Cape. "I orbited over the Banana River and listened in to the activities on the air-to-ground. I watched this thing go." While following the voice communications, he was amazed to witness the McDonnell-Douglas F-4 aircraft intended to provide chase coverage "that were as good as we had in service [at that time]," being left standing as the rocket thundered to orbit. Later, back at Jacksonville, his friend asked what he thought of the spectacle. Mattingly replied that it "[sounded] like the most exciting thing anybody could ever do." His friend then asked if he thought they could get into the astronaut program, which Mattingly was not so sure about: "We'll never get there, but if someone ever said you could, you ought to say yes," he replied.

Almost a year later, Mattingly was chosen as one of NASA's nineteen new astronauts (Group 5). [8] Then, seven years after seeing Young launch onboard *Molly Brown*, Mattingly and Charles M. Duke Jr. were launched on their own first space missions. Apollo 16 was to become the fifth lunar landing mission and was under the command of the same John Young, now on his fourth space flight, with Duke serving as Lunar Module Pilot and Mattingly as Command Module Pilot.

A SPLENDID PARTNERSHIP

Thirty-five years after the Gemini 3 mission was flown, Flight Director Gene Kranz wrote that the partnership of Gus Grissom and John Young "proved to be a splendid one." Both men, Kranz wrote, had a clear desire to fly, were a dream to work with and, for the short test flight of Gemini 3, both men were a perfect choice.

Gus Grissom liked to call his 'partner' on the flight a city boy, because although he was raised in what Young still liked to call "the small town of Orlando, Florida," he was actually born in San Francisco. Additionally, Grissom, a seasoned pilot in the USAF would not let the rookie astronaut and brown shoe naval aviator forget his days in the "black shoe navy." Grissom later wrote that Young was "not the talkative type, but he's got a good sense of humor, which is a prerequisite in this space business." Young's inclination not to waste his words was something which became evident over his forty-year astronaut career, but this hid an incredible talent for engineering detail. Like Grissom, he preferred to shy away from publicity to focus on the job in hand.

Grissom commented, "John and I had practically lived with our spacecraft since the first rivet was put into it at the McDonnell plant." [9] As the various systems were installed in the spacecraft, both men studied each one intensely and "sweated out the glitches along with the McDonnell engineers." This gave them added confidence in the hardware as the mission approached. Grissom recalled one incident during their preparations for the mission, where a reporter suggested that the astronauts were nonchalant in their approach to the flight. In a reply that was typical of him, Grissom explained, “It is not nonchalance at all, but the assurance that, barring a total disaster, I knew our spacecraft was going to work. It was simple as that.”

Clearly, Grissom was proud of his association with Gemini, as he had been in on the program from the beginning and his background in test piloting and engineering came into its own. It became clear, after flying *Liberty Bell 7*, that he would not have the chance of an orbital Mercury flight, so he saw Gemini as an opportunity to attain his second spaceflight. It was an inspired move and, with Grissom’s tenacity, one from which the program benefited as well, with the astronaut’s determination to make Gemini the best yet. To him, Mercury was a reliable Volkswagen compared to the sleek Corvette lines and systems of Gemini. Grissom’s ability to converse with the engineers at McDonnell made him the ideal choice to lead Astronaut Office efforts to put Gemini into orbit, in the safest possible condition and with the best systems and capabilities the design could offer available to the crew.

Often, he noted that the most significant difference with Gemini was “the amount of control the pilot exercises over all the functions. Gemini is the first true pilot’s spacecraft.” [10] The maneuvering capability and the demands placed on the pilot was something Grissom repeatedly emphasized in his speeches, reports and interviews: “Gemini,” Grissom noted, “will be a pilot-controlled operational spacecraft, not just a research and development vehicle.” Mercury may have been classed as a ‘capsule’ but in Grissom’s mind and to his colleagues, Gemini was a true ‘spacecraft’. “Gemini’s future looks bright,” Grissom said in the run up to the first missions. “We have all the know-how in our hands now. It will not take the development of unusually new techniques to put Gemini into orbit. The training is tough and a lot of knowledge had to be crammed into our skulls.”

According to his wife Betty, Grissom “practically lived at the McDonnell plant in St Louis, prodding engineers and administrators to levels of near perfection even above their own desire for technical excellence. Gus was justly proud of Gemini and the thousands who were building them, and he drove himself harder than ever to make it a success, never letting anyone forget that there would be astronauts on board.” This was demonstrated by the two men taking a notebook with them into the flight simulator, jotting down all the details of any problem they encountered as they worked on system after system.

Spending so much time at McDonnell meant the two men saw less and less of their families back in Houston. To save travel time, Grissom and Young shared a small, two-bedroom apartment near to the McDonnell factory in St Louis. Each night, they meticulously reviewed the day’s events and issues, deciding who would follow up the outstanding issues and on the division of labor during the mission. [11]

Grissom lived Gemini night and day, determined to command that first manned test flight, but a moment of carelessness almost cost him the seat. A few weeks prior to the flight, he was relaxing in the Bahamas when he inadvertently banged his left hand against a door during a light-hearted moment at a party, possibly breaking a bone in his left wrist. Within minutes the wrist had swollen up to twice its normal size. Fully aware of what this might do to his flight status, Grissom decided there and then not to tell anyone or to consult a doctor and as a result, he never found out whether or not his wrist was actually broken. He embarked on a careful, private program of exercise to reduce the swelling and his dedication paid off, passing the flight physical with very few the wiser. Grissom was determined, almost no matter what it took, to take that first Gemini command seat. [12]

The “splendid partnership” of the first astronauts of Gemini, walk proudly to their date in history. John Young leads Gus Grissom up the ramp towards the elevator that took them to the White Room and the awaiting *Molly Brown*. The astronauts are followed by suit technicians Joe Schmitt and Al Rochford. (Courtesy Ed Hengeveld).

According to Young, both he and Grissom thought that being involved in the testing phase of Gemini was the most essential and, from a test pilot's standpoint, the most interesting element in the whole Gemini program. The success of Gemini 3 was down to the amount of work both men, together with their backup crew Schirra and Stafford, put into preparing for and flying the mission, ably supported by the teams at McDonnell, MSC and down at the Cape. Along with the unmanned flights of Gemini 1 and 2 and the subsequent post-flight operational briefings dissecting the flight of *Molly Brown*, the three orbits of Gemini 3 laid the groundwork for the achievements attained across the remaining flights of the program.[6]

WHAT'S IN A NAME?

During the Mercury program, it became traditional for each astronaut to name their respective spacecraft. This was an old tradition in the services, where pilots were allowed to name their aircraft. As the astronauts were all military test pilots it seemed logical, at least to the pilot astronauts, that this idea should be applied to the fledgling space program. With only seven astronauts in the program at that time, there was strong sense of fraternity between them in what they were all sharing and training for and to respect that, each spacecraft's name also included the number 7. For his Mercury flight, Grissom had chosen *Liberty Bell 7*.

Grissom had expected to carry on this tradition with Gemini and, while thinking about it, could not get the misfortunes of his *Liberty Bell 7* out of his mind. His Mercury spacecraft "sank like a stone when her hatch blew prematurely [and] I nearly went down with her," he would write later. His initial thought was to use some kind of traditional Indiana name, perhaps from the native tribes which roamed his home state. If he was going to follow this course, however, he realized that he would need some help in choosing the right name. [13] Grissom contacted the research staff at *World Book Enterprises* and *Life Magazine* to investigate the idea. What they came back with was "Wapasha," the name of a succession of Mdewakanton Sioux chiefs, after whom the 503-mile (810 km) Wabash River in Indiana is named. The name actually derives from the English spelling of the French name for the river "Ouabache," which in itself came from the native name of "Waapaahšiiki," whose meaning translates to "it shines white," or "pure white," or even "water over white stones," reflecting the clarity of the river over the limestone found in Indiana.

[6] In addition to the NASA's own Gemini program, the USAF had expressed interest in flying Gemini missions for their Manned Orbiting Laboratory Program (MOL, 1963–1969) and had selected a cadre of 17 military pilots. Though their training was mainly focused upon the systems and hardware of the MOL laboratory and in the clandestine observations that program was to explore, the launch and recovery phases would be on a ('Blue') Gemini spacecraft, suitably modified for its new role. Those modifications included a transfer hatch in its heat shield, the integrity of which was tested in the re-flight of the former Gemini 2 spacecraft, on its second unmanned suborbital flight in November 1966. This was the only flight in the MOL program, which was cancelled in June 1969. [8]

Grissom and Young liked the idea of a Native American name going into space, until it was pointed out that someone would soon start calling Gemini 3 the "Wabash Cannonball." This came from a late 19th/early 20th century American folk song about a fictional train. Its meaning is varied. According to some hobos (American travelling workers), it was a mythical train which was a "death coach" to carry the souls of hobos to their reward, while other stories suggest it was a 700-car train on the Ireland, Jerusalem, Australian and Southern Michigan line constructed by Cal S. Bunyan, brother of Paul Bunyan, the giant lumberjack of American folklore. This train was said to travel so fast that it arrived at its destination an hour before its departure. According to the hobo legend, the mythical train traveled so fast that it took off and entered space and is still traveling there. Despite the rather tenuous space link, Grissom was also concerned that as his father was working for the Baltimore and Ohio Railroad at the time, he would probably not appreciate his son taking the name of a train from a different line for his spacecraft, even if it was mythical. So, not wishing to cause his father embarrassment among his work colleagues, Grissom dropped the name "Wapasha" from his shortlist.

Around the same time, there was a musical comedy called "*The Unsinkable Molly Brown*" coming to the end of its run on Broadway. Grissom soon made the connection to his earlier flight on *Liberty Bell 7*. "I'd been accused of being more than a little sensitive about the loss of my *Liberty Bell 7*," he later wrote. "It struck me that the best way to squelch this idea would be to kid it and from what I knew about our Gemini spacecraft, I felt certain it would indeed be unsinkable." So, both Young and Grissom agreed Gemini 3 would be christened "*Molly Brown*." This caused a bit of conflict, with some of the NASA hierarchy liking the name while others did not. When asked for a second choice, Grissom replied "What about the *Titanic*?" This was not what the NASA managers had in mind, but while not officially condoning the name, they did not ban it either, so Gemini 3 became "*Molly Brown*." It would be the first and only Gemini to receive its own flight name.

Grissom wrote that the decision to cease naming spacecraft was because it was not really reflective of the "high scientific aims of our national space program," but refuted that Gemini was being portrayed as a cartoon strip, with a bunch of 'Red Baron' aviators apparently dog fighting in space. Grissom also suggested that perhaps the real reason to drop the naming was that if they had authorized a continuation for the rest of the series, the NASA management were worried about what name practical joker Wally Schirra would come up with for Gemini 6.

Ironically, barely four years later, American spacecraft would have to be named once again out of necessity, starting with the Apollo 9 flight in March 1969 that was the first to require separate radio identification callsigns for its Command and Lunar Modules. For the time being, however, Gemini spacecraft number 3 became widely and affectionately known as "*Molly Brown*."

The Gemini 3 Emblem – or lack of

In the current space program, we are well aware of the individual mission emblems that are designed and produced not only for each manned mission, but also for many payloads, unmanned missions, personnel or objectives. However, in 1965, emblems were not so well known. Indeed, they were decidedly rare. There were official program emblems and each of the Mercury spacecraft had their name or artwork hand painted on the side, but after the 'storm in a teacup' issue of naming Gemini 3, it was decided not to provide a crew emblem for that mission, or Gemini 4. [14] However, a design was created and minted on 1-inch (25 mm) gold-plated, sterling silver medallions. A number of these were carried on the mission and then given to family and friends after the flight. According to some reports, the emblem was also printed on early editions of the cover of Gus Grissom's posthumously-published account of Gemini and in 1981, Young was seen wearing a post-flight production patch on his flight suit both before and following STS-1. As a final note, Grissom and Young were the last Americans not to wear the Stars and Stripes flag on their flight suits, a tradition which began on the next flight.

The 'official' unofficial Molly Brown mission emblem. (Courtesy Joachim Becker, SpaceFacts.de)

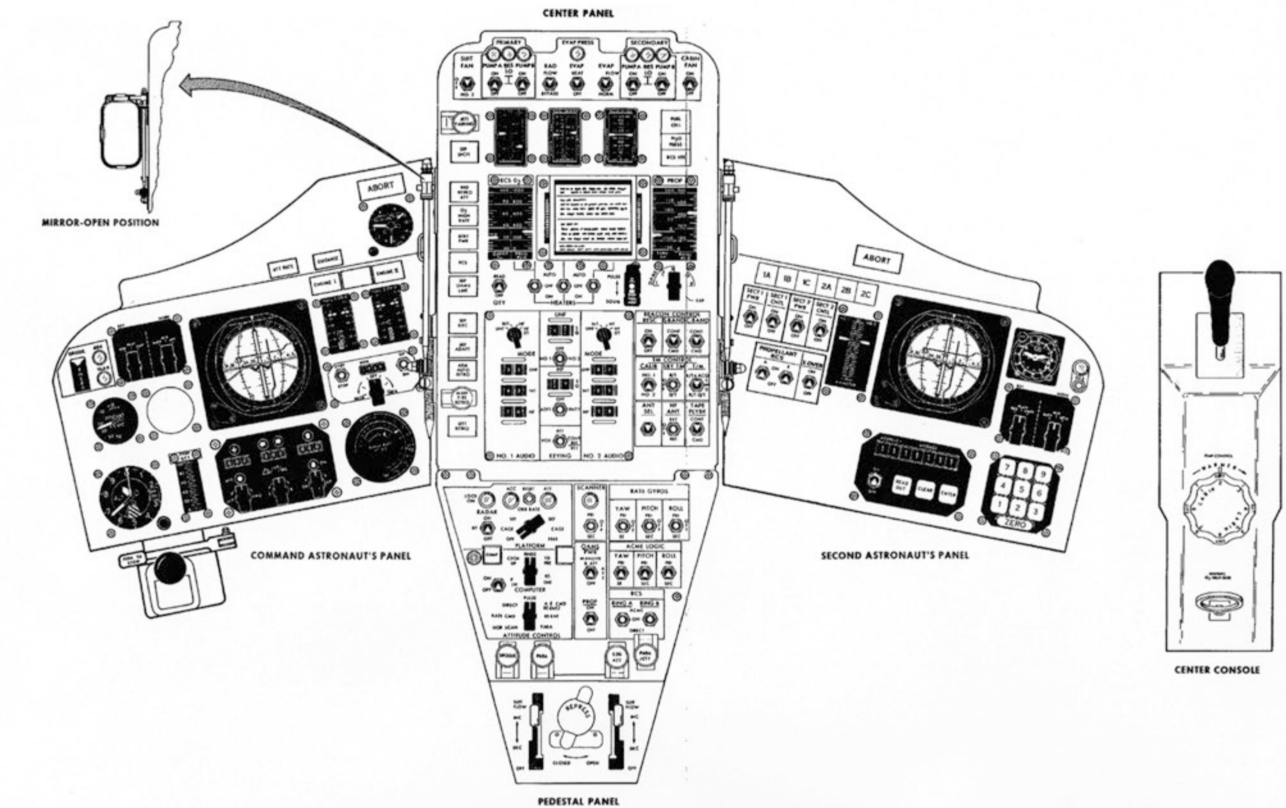
SUMMARY

Gene Kranz called the Grissom and Young pairing a splendid partnership and so it turned out to be. They were not originally intended to fly the first Gemini; indeed, they were not initially paired to fly at all, but the twists and turns of crewing have often been seen to produce results which were not clear only a few months previously. When the Gemini crewing was first being planned by Slayton, he devised a system of prime and back up astronauts, a team of two pairs, initially with a veteran astronaut guiding a rookie through the intricacies of spaceflight. Any of these four could fly the mission in theory. Slayton would then use the recent flight experience of the prime crew to apply to later missions, initially as backups but then perhaps flying a later mission, probably splitting the original team to pair the recently-flown veterans with new unflown crewmembers. This was an inspired and very successful, if not always popular, system. Exactly who won the seat and why another 'equal' astronaut was left out was one of the mysteries of crew selection which is still debated to this day.

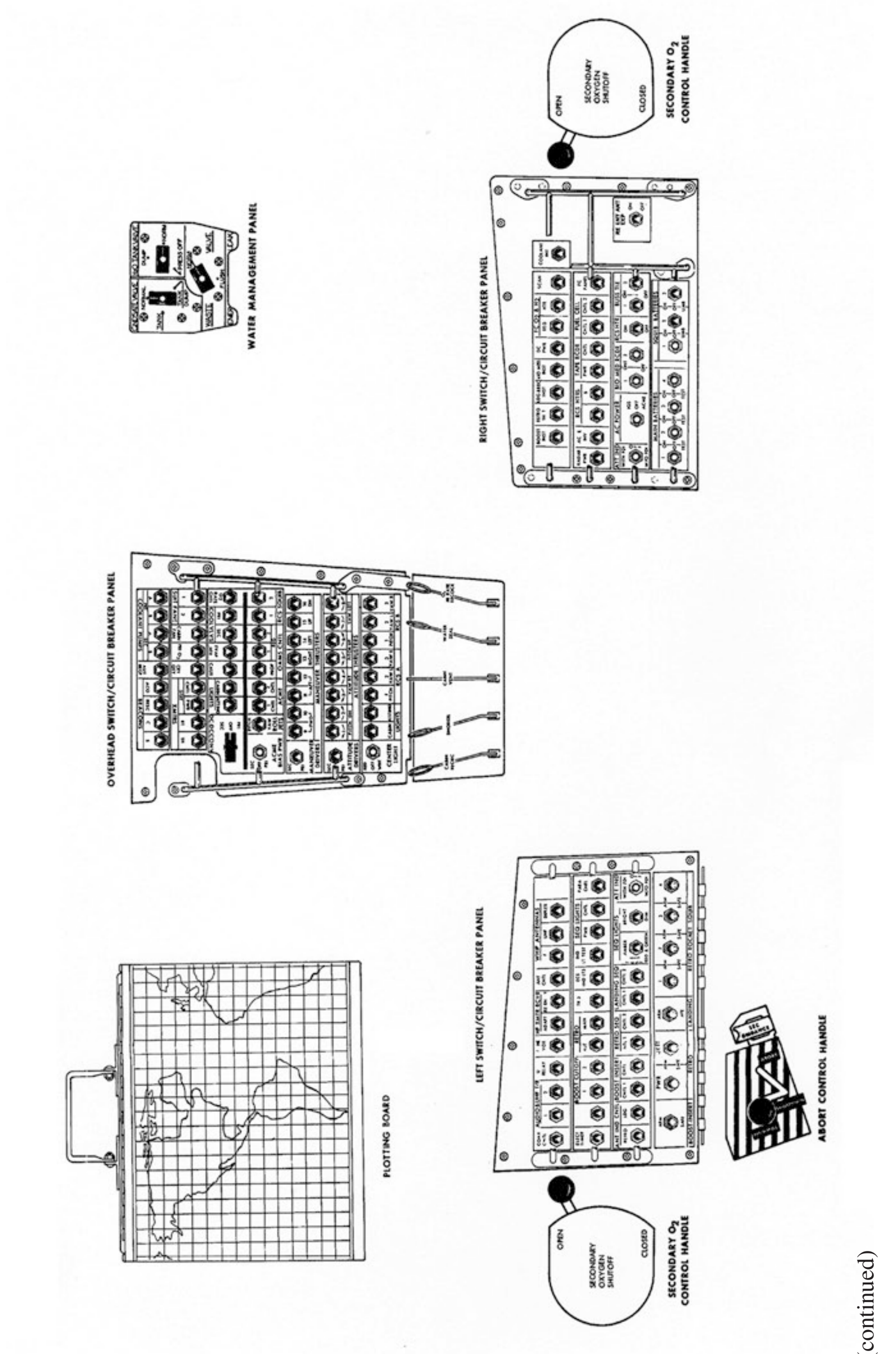
Whatever his reasons, Slayton chose to pair Grissom with Young and they set the standard for American spaceflight crewing over the next decade, encompassing all of Gemini, the Apollo era, Skylab and Apollo-Soyuz. Things had to change with the advent of the Shuttle and prospect of flying regular and frequent missions, but for the pioneering era of 1965 through 1975, this system worked well.

The tenacity of Grissom and Young blended well, as did their often-overlooked sense of humor. Grissom had grasped the prospect of flying on Gemini early in his astronaut career, shortly after completing his first spaceflight in 1961. Many sources and even his own words confirm that he was passionate and determined to ensure that Gemini flew well and safely and he wanted to use these experiences to move on to achieve a similar success, if not better, for Apollo. Sadly, he did not get the chance. John Young brought a different desire and drive to achieve to his first spaceflight. Years later, Young became known for issuing multiple memos on aspects of crew safety and reliability, a trait which he had probably learned from his lifelong interest in mechanical things and from his years in the U.S. Navy, but which blossomed when he joined NASA and flourished with his early assignment to Gemini 3.

Both men worked tirelessly to ensure that Gemini 3 was ready to fly and fly well. There were a few glitches and issues to address after the mission, of course, but on the whole the apparent smoothness of the Gemini 3/*Molly Brown* mission was down to the dedication both men devoted in the year prior to the flight and in the time that they had spent at NASA prior to that. The flight of *Molly Brown* may only have been relatively short at three orbits, or less than five hours and has perhaps been lost in the latter achievements of the program, but the importance of the mission was not lost on the two astronauts who flew that historic first voyage on Gemini.



To supplement the narrative of the flight of *Molly Brown*, these two diagrams (on pages 172 and 173) illustrate the layout of the Gemini 3 instrument panels and associated displays.


WATER MANAGEMENT PANEL
OPEN
SECONDARY OXYGEN SHUTOFF
CLOSED
SECONDARY O2 CONTROL HANDLE
RIGHT SWITCH/CIRCUIT BREAKER PANEL
OVERHEAD SWITCH/CIRCUIT BREAKER PANEL
PLOTTING BOARD
LEFT SWITCH/CIRCUIT BREAKER PANEL
ABORT CONTROL HANDLE
OPEN
SECONDARY OXYGEN SHUTOFF
CLOSED
SECONDARY O2 CONTROL HANDLE

(continued)

References

1. A detailed account of Grissom's first spaceflight can be found in **Liberty Bell 7, the Suborbital Mercury Flight of Virgil I. Grissom***,* Colin Burgess, Springer-Praxis, 2014.
2. For a full account of John Young's early years and career see **Forever Young: A Life of Adventure in Air and Space**, John W. Young with James R. Hansen, University Press of Florida, 2012; see also *John Young, One Man's Conquest of Space,* David J. Shayler, *Spaceflight* Volume 24, No. 5, May 1982, pp. 221-224; Volume 25, No.1 January 1983, pp. 30-32, No. 5, May 1983, pp. 219-220, No. 6, June 1983, pp. 275-276, and Nos 9/10 September/October 1983, pp. 370, British Interplanetary Society; and *John W. Young American and International Hero*, by Dana Holland, unofficial website www.johnwyoung.org [Last accessed December 4, 2017]
3. Astronautical and Aeronautical Events of 1962, p. 28 and p. 47.
4. **Forever Young: A Life of Adventure in Air and Space**, John W. Young with James R. Hansen, University Press of Florida, 2012, pp. 48-50
5. Reference 4, p. 50
6. **This Day in Aviation: Operation High Jump**, Bryan R. Swopes, April 3, 2017. www.thisdayinaviation.com/3-april-1962, last accessed October 30, 2017
7. NASA JSC Oral History Project, Thomas K. Mattingly II, November 6, 2001.
8. **The Last of NASA's Original Pilot Astronauts, Expanding the Space Frontier in the Late Sixties**, David J. Shayler and Colin Burgess, Springer-Praxis, 2017.
9. **Gemini,** Virgil 'Gus' Grissom, Macmillan, 1968, p. 98.
10. **Starfall**, Betty Grissom with Henry Still, Crowell, 1974, p, 129.
11. Reference 10, p. 144.
12. Reference 10, p. 149.
13. Reference 9, pp. 93-95
14. **Liberty Bell 7, The Suborbital Mercury Flight of Virgil I. Grissom**, Colin Burgess, Springer-Praxis, 2014, pp. 64-65.

6

All systems look 'GO'

"Oh, man! Oh, man, you can see all the way across Mexico!"
John Young, onboard Gemini 3 as it neared the end of its first orbit.

The flight on the first stage of the Titan was very smooth, with the astronauts reporting little vibration or noise. At staging, however, they certainly noticed the abrupt change in noise and a flash of flame around the spacecraft during the "fire in the hole ignition" of the second stage. Post-flight, it was reported that the first stage of the Titan had burned "hotter than normal," referring to its higher performance than expected rather than to temperature levels. Combined with the normal pitch program, this excess performance sent the vehicle to a higher altitude than expected at staging, though it was never out of the bounds of the trajectory. This had also been observed on the two earlier unmanned missions and indicated that the engine model employed needed revision, along with modifications to the pitch program. This was not necessarily a bad situation, as it suggested that there was capacity for increased payloads in future. While the first stage was firing the radio guidance system followed a programmed flight, but during the second stage it took over, steering out any errors, smoothing out the trajectory and pitching down to a point where the nose of the spacecraft was slightly lower than the horizon before gradually returning to an attitude slightly above level. The astronauts reported that the second stage was also smooth, but were aware of a slight throbbing noise during the powered flight which was probably as a result of flying just a single engine on the stage. Although the backup guidance had displayed a moderate pitch error during the latter stages of the second-stage flight, it would have given a satisfactory orbit if called upon. Meanwhile, the primary system had placed Gemini 3 into an orbit which was calculated at 100 × 140 miles (160.9 × 225.2 km) at cutoff, but with a velocity of about 12 miles per hour (19.30 kph) lower than expected.

Now, it was time for Grissom to go to work and initiate the first burn of the flight using the Gemini engines. He confirmed post-flight that he had received the expected reading at SECO (Second stage Engine Cut-Off): "As I made my burn, it counted up. I started making my burn on time and then I forgot what time I started, so I just burned until I knew I

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_6

had burned long enough [resulting in a velocity increase of about 10 ft./sec or 3.048 m/sec] …the nose of the spacecraft was right on the horizon" [1] Grissom never heard the OAMS thrusters, which he had expected to, while Young could only barely hear them. With Grissom concentrating on the attitude, Young tried hard to hear the engines burn to confirm their firing before he hit the SEP [Separation] switch to fire the pyrotechnics to separate the Gemini from the Titan's upper stage. To Young, that separation sounded like 105 mm (4 inch) howitzers. He had been very careful not to move his hands toward the SEP switched while under *g* loads, commenting post-flight: "If you ever hit the wrong one, it would be a national disaster."

"You know when you have separated," said Grissom. "The only thing that concerned me was that I wasn't sure if we were thrusting." Grissom worked out that he could determine the thrusting as the controls of *Molly Brown* were behaving exactly as they had in training. He saw the spacecraft pitch down and had to use the PITCH-UP control, which told him that the CG (center of gravity) was in the right spot, though he noted that there should have been more lift than they had. He assumed that they had a CG shift after separation. He reported that the OAMS control was "good and smooth," but thought the roll rate was pretty high, though he managed to dampen it out.

Gemini 3 leaves the pad, March 23, 1965. [Inset] Astronaut Clifton C. Williams is shown at console in the Mission Control Center (MCC), Building 30, MSC, Houston. The team at Houston monitored the flight of Gemini 3 but it was controlled from the Cape. Here, Williams serves as 'Tank monitor' on the status of the Titan II launch vehicle, during final minutes of countdown, the launch and ascent to orbit. Even though Williams was a bone-fide astronaut he is wearing a 'Visitor' badge on his jacket pocket. As the MCC was not yet fully operational, *all* controllers at MSC wore visitor badges until Gemini 4. (Courtesy Ed Hengeveld)

Then suddenly, at separation, Young noted "all this stuff [outside the windows] comes flying up over the windscreen. I never saw anything like it." Grissom added "Yes, stuff is all around, like shrapnel. It disappeared pretty fast, moved right out ahead of us."

As Gemini separated, it entered orbit 'on its side', leaving Grissom to roll *Molly Brown* 90 degrees, which he accomplished successfully, holding attitude for the insertion burn and attaining the required velocity increase.

Once on orbit, both men worked on reconfiguring Gemini from being a payload on top of a rocket into a fully working spacecraft.[1] "We went through the insertion check list. We didn't test the sequence lights at this time," recalled Grissom after the flight. [2] "We stowed the arm rests, but I never did stow the elbow support. It stayed up the entire flight. I didn't notice that it was up until we were re-entering. I started to, but did not put it down at this time." He also found that the roller device which allowed him to advance the rolled-up flight plan as they progressed through the mission had stuck, but he broke it free. After the flight, Grissom found that it was dirty, which he believed had caused it to stick. "The way that flight plan roller is made, you just don't see enough of it so that you are aware of what is coming up next. You don't get a chance to prepare for it," he commented during the debriefings, adding "There is something wrong with that flight plan roller. It is a good idea, but there is not enough space. You need a better way to keep track of the mission, and how the mission is going."

Young had stowed his inboard arm restraint (the left, next to Grissom) but not the outboard (right hand) one, which he did not seem to need to do. He later used it to stack equipment against during the flight to stop it floating around the cabin.

The two 'D-ring' handles used to eject the seats in an emergency during launch also had to be stowed, which Young felt necessary to comment on post-flight: "It is practically inexcusable to be able to safety the rest of the seat and not be able to safety the D-ring. With the cover in zero-g, the D-ring floats right out of its stowage." To Young, this amounted to an unnecessary hazard and he felt that another way to stow the D-ring should be devised, suggesting perhaps a mechanical latching device to safety the system so that the D-ring was not inadvertently pulled in orbit. As the seat ejection system remained active during the descent phase of the recovery it could not be totally disabled, raising concerns over its accidental activation. However, Young did find stowing the drogue safety pin easier in orbit, "having sweated over it for the last month in 1 *g*." [3]

One of the first tasks for Grissom on orbit was to make sure they had everything ticked off their post-insertion checklist, which took much longer to complete than either they or the ground had expected. [4]

[Extracts from the mission air-to-ground throughout the next three chapters are in italics.]

Grissom:	*"Let's see, have we got everything on this checklist, John? Let's see – retrorockets safe. Yes… OAMS power… ATTITUDE."*
Young:	*"Maneuver controller – stowed. Sequence lights – test."*
Grissom:	*"Arm restraints, face plates – open."*
Young:	*"Secondary 0_2 bottle is closed. I've got mine. Waste valve to NORMAL."*

[1] Upon reaching orbit and separating from the Titan, Gemini 3 was given the international designation of 1965-24A, meaning it was the 24th major payload launched into orbit that year.

On the ground at the Mission Control Center (MCC), Gordon Cooper, manning the Capcom console at the Cape, asked Grissom how much better the view looked than it had four years earlier during his short ballistic flight on Mercury 4. Grissom confirmed that it looked nicer, hinting at his pleasure at finally making it to orbit. Then it was back to the checklist, although Young was experiencing difficulty maintaining communications with Cooper at the Cape as they headed out over the Atlantic.

Young: *"Computer – PRELAUNCH. High frequency is OFF. Antenna selector to ADAPTER…Cape Capcom, how do you read on adapter antenna? Over… Capcom,* Molly Brown*, Over."*

When Cooper did not reply, Grissom suggested that they may temporarily have lost communications with the Cape, but also told Young that he was having his own problems aligning the spacecraft.

Grissom: *"Man, it's hard to watch that gyro."*

Finally, he succeeded in his task. "I aligned the platform early," Grissom recalled postflight, "and alignment came right in. Even at zero-pitch attitude, it was easy to tell when you were finally close to zero. I couldn't tell exactly, but by pitching down it was easy to determine zero yaw. Subsequent to platform alignment, I went to orbit rate and then to horizon scan." Grissom said that applying DIRECT control to the spacecraft was easy. In DIRECT mode, he could apply ON-OFF commands to the various attitude thrusters, while in HORIZON SCAN mode, the system automatically provided pitch and roll attitude control to a reference from the Horizon Sensor. PULSE mode was retained for manual override in all axes.

Communications were still difficult as they headed over the Canary Islands, so Young gave up trying to call the Cape and pressed on with his next task of trying to get his blood pressure bulb in. As he struggled with that, Grissom commented that *Molly Brown* was still repeatedly trying to yaw to the left, without his input.

Grissom: *"We must have a leak."*

That got Young's attention:

Young: *"What kind of leak?"*

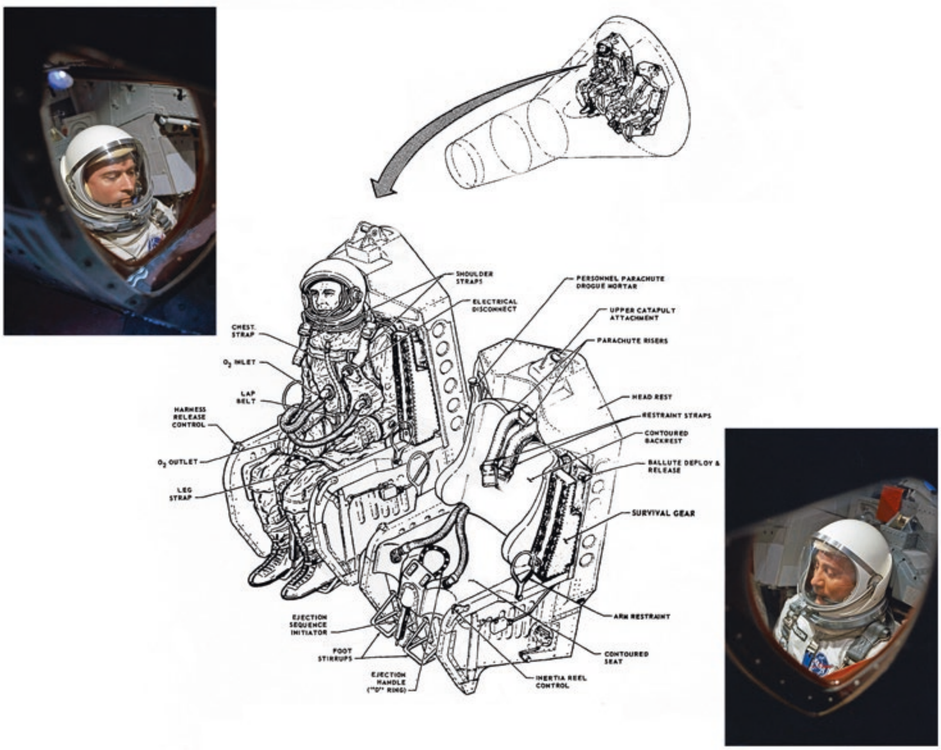
The suggestion was that one of the thrusters might be leaking.

Both astronauts then tried to extract the plot board from its stowed position so that Young could record data as they fired the spacecraft engines for 15 seconds, but Grissom was struggling to free the board in the confines of the cabin.

Grissom: *"I can't get the plot board out of these… I can't get it out John… I'll darn sure never get it [back] in. Oh yes, there it comes."*

It was now 15 minutes and 16 seconds into the mission of Gemini 3, at which point the Canary Islands Capcom called the spacecraft to report that they could hear the astronauts loud and clear. Grissom reported the same.

Capcom: *"All systems look good on the ground."*
Grissom: *"OK, we look pretty good up here."*



[Main image] Seating arrangements of Gemini. [Inset left] Young in the Pilot position. [Inset right] Grissom in the Command Pilot position.

Capcom was now ready to read up the data from the burn and an update for a re-entry at the start of the second orbit, in case a contingency situation or loss of communications required a rapid return to Earth. Young quickly wrote the figures down, before reading them back to the ground to ensure they had copied them correctly. In the days before advanced computers and digital recording, using paper and a marker pen or pencil was still the best method of recording data updates during the flight. Capcom also requested that the radiator switch was put into the FLOW position.

Young: *“Roger. Radiator is in FLOW position. [It] Has been the whole pass [over the Canaries]. It’s cooling us right down too. It’s working.”*

Next, as they completed the UHF #2 communication check, the ground asked once again for the radiator switch to be set to the FLOW position. Grissom reasoned that they had not heard the information the first time and realized that Young’s communications system was set at RECORD, preventing the ground from hearing him. Once he switched to TRANSMIT, Young repeated that the radiator was in the correct position and that UHF had been on #2 for the whole pass. He then sent down the blood pressure reading he had taken earlier. After the flight, Grissom noted that it might be better to install a separate switch for

RECORD and added "I would like to see one on the center panel, so that both of us could use it to record whatever we wanted to do."

Grissom was then advised by Capcom of the increase in their orbital velocity, amounting to 12.6 ft./sec (3.81 m/sec) during the earlier 15-second burn. It was at this point that Grissom indicated they were experiencing the slow drift to the left.

Grissom: *"Roger, I understand. I seem to have a leak. There must be a leak in one of the thrusters, because I get a continuous yaw left… very slight… very slow drift."*

Capcom also informed the crew that their outlet temperature was "off scale high" and that the radiator inlet reading was 74 degrees F, indicating that the water boiler (heat exchanger) was not doing its job. The crew responded by configuring the radiator back from FLOW to BYPASS.

Young commented on this during the post-flight debriefing "We went to FLOW on the radiator the first time over the Canaries. Then [over] CSQ we went to FLOW [again] on the radiator and [the ground] gave us an outlet temperature of 42 degrees. So I left it in FLOW and when we got over Carnarvon we went to single-loop operation. At that time, our suit inlet temperature was 54 degrees. I want to base going to the single-loop operation on crew comfort. It seemed to me as if we were nice and cool. So I shut off the secondary loop and went to NORMAL on the evaporator instead of MAX FLOW. We stayed in that configuration for the remainder of the flight."

Young reported that their suit inlet temperature never went beyond 54 or 55 degrees F (12–13 degrees C) during the night pass or 58 or 59 degrees F (14–15 degrees C) in the daylight pass, except for the times when they went to HIGH RATE FLOW. He considered this to be "really good." For workload periods, the compressor flow was marginal, which they had realized from the heat load buildup in their suits. Young also predicted the situation Ed White might find himself on Gemini 4. At that time, White was training to open the hatch and just stand up, not completely exit the spacecraft. Young realized that such a workload would require his colleague to dissipate the heat in his suit and have two compressors running at the same time to handle the situation, "or run the risk of compromising the mission."

Grissom added that he never really felt uncomfortable, though it was certainly not as cool as when they were sitting in the vehicle on the launch pad. "I could see [that] the work John was doing could build up a heat load which could develop into a serious situation before too long," he said, adding, "With no more physical activity than I was doing there wasn't a problem, but I thought it should have been cooler than it was." [5]

Everything was timed from the moment they left the pad and to ensure the timers onboard the spacecraft matched those on the ground, Capcom advised Grissom to start their onboard clock at 20 minutes Ground Elapsed Time (GET) on his mark.

Capcom: *"MARK! [20 minutes GET] Did you copy* Molly Brown*?"*
Grissom: *"Roger. I copy and sea urchin eggs activated."*

S-2 Sea Urchin Egg Experiment

The other reason for this timing mark was to ensure that the first science experiment would be activated on Gemini. The S-2 Sea Urchin Egg Growth Experiment was located on the left-hand hatch above Grissom, who had activated it as close to the prescribed time as possible and as close to the 'MARK' from Capcom as he could. He had to rotate a handle on the controller at set times during the flight, which allowed both the fertilization of the eggs and the release of the fixative solution to inhibit their growth at various stages of development. There were no system interfaces other than mounting brackets and no further input by Grissom was required, other than rotating the handle. Grissom then reported to the Canary Island Capcom that both the control checks and the insertion checklist had been completed, which was acknowledged. Capcom then advised the crew of a potential solution to the problem of the yawing thruster.

Capcom: *"I've been advised from the Cape you might put your prop switch off and recycle a couple of times, and it might stop your leak."*

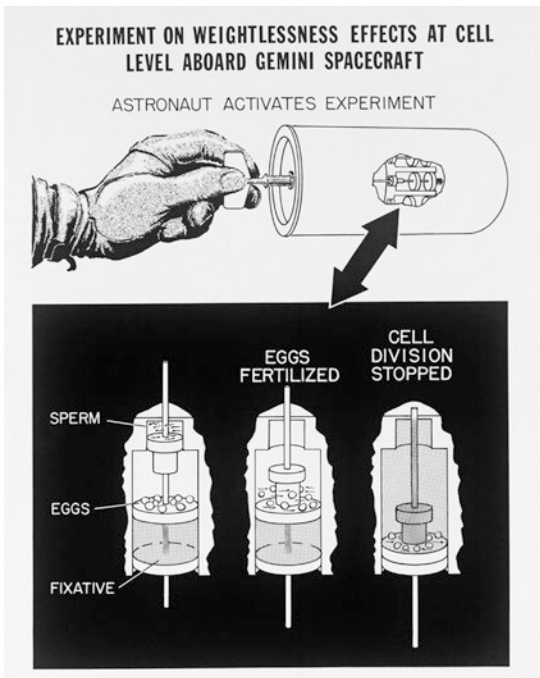


Diagram of the sea urchin experiment. The round canister on top is the experiment package with eight identical chambers each containing sections of sperm, eggs, and fixative. Turning the handle fertilized of a portion of eggs, which were then to divide.

The crew tried this and it seemed to work, as ten seconds later Young reported that it was not leaking.

Young later recorded that he had not been satisfied with logging the latest updates from the ground on the flight plan during the flight. Both astronauts were busy and had not yet taken out their flight books when the ground gave them updated information. Recognizing the need to capture this important information, but not having the correct documentation at hand to do so, Young quickly logged all the updates on the flight cards which, he soon found, was not the best solution. "I'm not sure of the correctness of this information," he reported later. "I am not satisfied that we have the proper method of receiving and logging this kind of information." They had received data from the ground which was not in the same format as the forms that they had onboard. The ground stations were giving them the correct updated re-entry parameters, but it was spread out and in a different order. "I consider this extremely bad due to the critical nature of this type of information," the rookie astronaut recorded post-flight. "If you ever got in a tense situation, you want that kind of information given in the same order every time, so that the flight crew recording it can get it down and get it right first time." Young suggested that some sort of recording capability should be set up at the crewmembers' fingertips, so that when data came up from the ground there would be no need to find a flight card or search for a piece of paper and something to write with. On board *Molly Brown*, Young had just recorded the information immediately on whatever he could.

Grissom commented that he had an effective way of doing this, which was probably based on past experience. The veteran astronaut simply took one of his pencils and wrote the updates directly onto his flight suit. "Well that's fine," noted Young in his post-flight debriefing, "but in a two-week mission, you are going to run out of flight suit." He recommended a properly configured kneeboard, as the old plot board was no longer suitable. He did not recommend writing on the flight plan either, because it was hard to read afterwards. Grissom confirmed that the flight plan strip was difficult to read due to inadequate lighting and he could not read the additional information both he and Wally Schirra had written on it in pen before the flight. "In fact, I didn't know some of them were there until I got it back and looked [the day after the mission]." Young had taken out the chart book but then found there was no place to secure it, so he reverted to the smaller file cards "You can just slap them to the wall," the astronaut stated. Grissom also stated that he liked to keep often-used information in the pockets of his flight suit, ready at hand when he wanted it.

The problem, they both said, was that neither of them had thought about copying down the next lot of data until they were over the station, so that when the ground asked, "Are you ready to copy?" the astronauts had to scramble for the plot board and find a page to write on. A knee-board would be much easier. Grissom preferred a fiber tip pen, as it would write anywhere; on the instrument panel, on the spacesuit, or even on the window. Today, of course, over fifty years after *Molly Brown* flew, such hand-written updates, pens and paper are very much a last resort, because the crews have a multitude of computerized platforms to work with.

Just over 20 minutes into the flight, Grissom turned his attention once more to the sea urchin experiment, moving the handle twice. "But it seemed to me," he later recalled, "[that] it moved too far. At least, it moved further than it did [during training]." In fact, the experiment was not working. Despite several attempts to initiate it, the experiment was inoperable, though the astronauts were unaware of the problem as all they had to do was operate the handle. Grissom later wrote that perhaps he had "too much adrenalin pumping" when he turned the handle. The astronauts were aware that the movement was more than they had experienced during training. The operation of the handle should have been a twelve-degree rotation to the right and then release, after which it should have returned to its start position. This should have caused a piston in each of the eight chambers to provide fertilization and fixing at discrete time intervals. Post-flight, it was found that the handle operating mechanism had failed and the fixative had leaked, with the silicone rubber O-rings used as dynamic seals in each chamber slightly permeable, rendering the experiment unsuccessful. The controller who was duplicating the experiment on the ground had also broken the handle in the same way. A modification was made to the hardware after the flight and it was planned for flights on the unmanned Biosatellite I and II missions, but was cancelled prior to flight due to the failure to find a suitable treatment to detoxify the plastic hardware successfully.

As the mission clock ticked to 23 minutes into the flight, Gemini 3 was over the eastern Atlantic and fast approaching a significant landmass.

Grissom: *"We are over Africa, John… if you'll give me the camera, I'll take a couple of pictures."*

The crew was also finding that they were battling lots of loose material in the cockpit, which had worked free and was floating in the microgravity environment.

Grissom: *"There are all kinds of junk floating around in here."*

Young commented on the situation post-flight and reported noticing screws, unidentified bits of plastic and a lot of dirt floating around. He suggested that a better method of cleaning the spacecraft should be found for future missions and that during the final systems tests at the contractor, the ejector seat [frames] should be fitted flush with the walls all the way around to prevent shavings and debris from falling down in the seat area and ending up "in the bilges" at the lowest point of the spacecraft. That was where everything would naturally gravitate to in 1 *g*, but in microgravity all that debris would float up and become a problem when the spacecraft reached orbit. Young warned that such debris could be a hazard on future flights if, for instance, loose pieces of metal got into the equipment and caused a short. What was not mentioned in the post-flight reports was the distinct possibility of such small particles floating into the eyes of the astronauts, potentially endangering their vision, or the potential of perhaps inhaling them. In raising these concerns, the crew had a direct influence over improvements to the environment in which future spacecraft would be constructed, tested and prepared.

Meanwhile, back in Mission Control at the Cape, PAO Paul Haney updated listeners on the recent events going on aboard Gemini 3:

> PAO Haney: "This is Gemini Control. We're 25 minutes into this mission and everything is doing very nicely. Over the Canary Islands, the command pilot, Gus Grissom, performed control mode checks in all roll, pitch and yaw maneuvers very nicely. He updated his clock. They activated the sea urchin experiment twice. Meanwhile, John Young performed communications checks with the Canary station, took a blood pressure reading, pumped up the grip on his left arm; he did an orbital update on the computer and he performed a suit integrity check on his suit. We're in good condition at this point. We're over the Kano, Nigeria site and the voice [communication] is being remoted back here to the Cape. Gordon Cooper is in conversation with Gus Grissom at this time. This is Gemini Control." [6]

As Gemini 3 flew over the African continent for the first time, the two astronauts continued to discuss the pitch problem. Grissom had noted a horizon scanner IGNORE indication and wondered aloud what might have caused it, noticing that the Gemini was pitching over again and there was nothing he could do to prevent it. Young asked if the scanner IGNORE was driving it, which Grissom agreed might be the case. Young then thought he had found the answer, noticing that his knee was inadvertently hitting the control stick which might result in an accidental input to thrusting. Grissom did not think so, however, as that would only occur in PULSE MODE, in which he could change the angular rate about all three axes by commanding thrust in incremental steps for a set period of time to perform fine attitude control movements. Meanwhile, Young had noted that the oxygen pressure had suddenly dropped in their suits and spacecraft and observed that they had to get the cabin pressure back up to the correct level. If they had a leak in the maneuvering system, Young suggested, then that was exactly the type of event that had been encountered during the unmanned Gemini 2 two months earlier, with an unexplained decay in its cryogenic pressure.

When Young asked Grissom to look at the cabin pressure level, the veteran astronaut's attention was diverted elsewhere, examining some troubling readings on other instruments until, slightly anxious, he queried his colleague's report of the loss of a system, without letting Young finish his sentence before asking:

Grissom: *"Lost what? What have we lost?"*

Instinctively, Grissom reacted by closing his visor on the suit, recalling later that "if the oxygen pressure [was] really gone, it won't make any difference. You've had it already." He then realized that his rookie pilot was a lot smarter than he was, noting that Young, still with his visor up, was not suffocating and had simply reached up and switched to the backup convertor. A slightly embarrassed Grissom lifted his visor and continued breathing normally. Though not recorded in the air-to-ground tapes (probably edited out), debriefings or press conferences, the incident must have raised a few choice comments and Young would almost certainly not have passed up the opportunity to tease his Commander over the incident.

Young confirmed the loss of a primary convertor, which had turned the heater off, then turned the mains back on. Grissom was concerned whether the converter's switch had inadvertently been knocked to the OFF position, but Young pointed out that the switch in question was actually above them on the overhead panels, so he could not have knocked it inadvertently. Even after switching the mains back on, the primary dc-dc convertor remained inoperative. After the flight, Young stated he was not happy with the dc-dc convertor system as it had dropped off very early in the mission, failing right after they had passed over the Canary Islands. "I had been looking out of the window," Young explained. "Things were bright out there. When I looked back in, the first thing I saw was the ECS 0_2 pressure reading 250 psia [172.5 bar]." He thought the system had backed off as expected but then realized that they had to put some manual heat into the cabin, "or we're going to be breathing some liquid oxygen."

Grissom added that it was at this time that they noticed the cabin pressure indicating zero, while they both had the face plates of their suits open. "Everything was going all wrong at the same time, which should have given us a clue… [but] it probably didn't take us more than 10 seconds to take care of it," he explained. Grissom acknowledged that the convertor failing to come back on was the biggest surprise of the flight and the possibility of shorting another system was a concern. Young concurred. "The only thing I can think of that might cause that would be some piece of equipment shorting it out in zero-g." There were perhaps 12 minutes of intermittent failures before the permanent failure occurred, causing a significant number of the crew displays to go out as well. Their training quickly kicked in, as they recognized such a sequence from the simulations and knew that it was not a nominal situation. They diagnosed the facts in front of them and switched to the backup system to restore their instrumentation. After the flight, an analysis of the spacecraft revealed that fortunately, the failed convertor was in the Re-entry Module. A nut that had been restraining a filter had come loose because it had not been properly locked and it had floated around in the convertor, shorting out some lines. For subsequent spacecraft, the faulty locking device used to restrain the nut was replaced. As Grissom later recorded, "We had plenty of oxygen. We just didn't have the right readings."

Gemini 3 was now in range of the Kano tracking station in Nigeria and the Capcom came back on line to ask them about the status of the rogue thruster.

Grissom: *"It's still GO. We're still drifting a little bit Gordo [Cooper, at the Cape]. It's not bad. I can hold it with PULSE with no problem. But we did lose our primary dc-dc converter."*

Cooper asked if they had tried their circuit breakers to try to cut off the errant thruster, to which Grissom replied they had not and that in fact they were not sure which thruster it was which was causing the problem. "*Yaw left… it would be either OAMS 7 or 8*," suggested Young, breaking into the conversation.

It was puzzling that they were not experiencing any roll, only pitch up. Meanwhile, Young had turned the auto heater back on but thought that they should turn it off until the cryo pressures came down again. As Gemini drifted along on its first orbit, Young noted how difficult it was becoming to see things inside the cabin.

Grissom: *"Hey! We're coming in on the night side… [adding a few seconds later] Look at that night come up."*

Grissom reported after the flight that throughout the mission, he had switched back and forth between the primary and secondary scanners, as they would drop out after a period of time and would not come back in. "Upon selecting the alternate scanner, the IGNORE light would come on in 30 seconds to a minute and … would stay on until we again selected the alternate scanner position." As a result, he was never entirely sure what was happening with the system.

Grissom was on his second flight into space, of course, but this was the first time both men had been in orbit and they were witnessing views that only fifteen people before them had ever seen. As they passed over the eastern coast of Africa and the Tananarive station, they were once again having difficulty in hearing Cooper back at the Cape, but were more mesmerized by the sight of lightning on the Earth below them.

Grissom: "*There is lightning out there… look at that stuff going by. Oh boy! Really does sparkle doesn't it… Now you can see those thrusters firing back there.*"

To which Young, ever economical in his use of vocabulary, replied, "*Yep!*"

It was now time for the two astronauts to take their oral temperature and blood pressure readings and then pass the readings to the ground. This was part of the bioinstrumentation system that was all carefully calibrated pre-flight. This system included two electrocardiogram leads featuring a pair of surplus Mercury program ECG electrodes, only used on Gemini 3 pending a new design for later flights; an impedance pneumogram (recording the breathing effort, heart rate, oxygen level and air flow from the lungs); an oral thermistor, which had a neoprene sleeve covered with Teflon and a bite grip attached; and a blood-pressure measuring system (BPMS) which, on the Gemini missions, was manually inflated as opposed to the semiautomatic system used on Project Mercury.[2]

Grissom was having difficulty in getting the blood pressure bulb in. Young suggested that he might be trying to put it at the wrong end, to which Grissom queried how he could tell the difference between either end. Despite working on the system for five minutes, Grissom simply could not insert the blood pressure bulb. It would not lock in place to allow him to pump it up. Later, Young was able to get his pressure bulb working at an elapsed time of 50 minutes 18 seconds into the flight, but the frustrated Grissom could not understand why his would not work. Young later reported that he had unpacked the blood pressure bulb shortly after orbital insertion. "I changed the waste valve to normal and stowed both Gus's pins and my pins, which was quite easy in zero-g."

During the post flight debriefing, Young expanded on his experience with the blood pressure device: "The blood pressure bulb [on Gemini 3] was an item we had never seen before, and it had two ends. One end we plugged into our suit, and Gus could not even get the blub into his suit; and the other end apparently may have been used for pulling water out of the adapter. After we got down in the [ocean] we used the same end to pressurize the drinking tank that we used for the blood pressure before, and it worked okay." For the blood pressure requirements on the flight, however, the system simply refused to work for Grissom. Apparently, the design had changed from the one they trained on, which did not help. "I spent fully five minutes trying to plug the wrong end of the bulb into my suit when we first got into orbit," Young reported post-flight.

Young: *"All I know is it won't insert in one end and it does insert with the other. I never saw a blood pressure bulb like that before this flight."*

Suddenly, the rookie astronaut's gaze was distracted by the view out of his window.

Young: *"Look at that! It's beautiful!... There's the Southern Cross and Alpha and Beta Centauri."*

Despite the busy flight plan, it was hard for the two men not to look out of the window and admire the view, although the small windows available in the crew compartment hatch doors were perhaps not the most suitable viewing ports.[3] However, the quality of visibility

[2] The Gemini medical experiments will be explained in more detail in the Gemini 4, 5 and 7 titles in this series.

[3] A large-scale viewing window was never included in spacecraft design until the era of space stations. It is a feature currently enjoyed by ISS astronauts, who can look out of the 7-paned Cupola for spectacular views of the world passing beneath them and of the cosmos.

through their windows on *Molly Brown* was another evaluation task for the two astronauts. Visibility changed slightly through Grissom's window, as a small amount of haze accumulated on the interior of one of the inner panes. "It looked like a little bit of moisture or fog," Grissom noted post-flight. "It got worse as I went along, though it wasn't bad enough to obstruct my vision."

Grissom wanted his pilot's attention back inside the cockpit and asked if Young could confirm whether the thrusters were firing, which he did.

Grissom: *"We are yawing. I've got to keep it from yawing so far around."*

In the interim, PAO Haney was keeping the listeners up to date and explaining the potential problem with the yawing thruster.

> PAO Haney: "This is Gemini control. We're 38 minutes into the mission. At this time the spacecraft is just off the southeast coast of Africa. In the Canary pass, and checking out the systems, Grissom reported later after the Canary pass to the Kano station some small difficulty with the yaw left thruster. In the electrical elements there are several circuits of electronics available; this was in the secondary electronic circuit. The problem is not considered a serious one and we are going to make another evaluation over *Coastal Sentry Quebec*, which is positioned in the middle of the Indian Ocean, in a few minutes. This is Gemini Control."

After their mission, the astronauts commented on the procedures which had been established for monitoring the status of the spacecraft as they flew around the Earth. Grissom reported they had little difficulty in this. "We kept a constant check on all of our gauges and all our quantity readouts," he recalled. "When we were using a system, we watched its performance closely." He thought that the spacecraft was adequately set up for monitoring onboard systems, but was concerned that, according to the flight plan and agreed procedures, most of their time was spent with the faceplate of their pressure suits open and part of the suit [the gloves] off. "It dawned on me [that] in flight, the cabin pressure could drop and you would never know it." If they were fully suited they would have been aware of a sudden pressure drop. "I wonder if we don't need a light or a buzzer or something to let the crew know that cabin pressure is starting to drop," he questioned, adding that he was concerned during the flight and kept a close watch on the gauges on the instrument panel.

Up on orbit, with the mission elapsed time approaching 41 minutes, Young was still working on the blood pressure blub. Less than two minutes later, contact was made with the tracking ship *Coastal Sentry Quebec* in the Indian Ocean. Grissom promptly updated the ground on status of the control system.

Grissom: *"Well, the control system is working fine. It's just that I have a very slight yaw to the left."*

Capcom apparently did not receive this information and asked the question again:

Grissom: *"All the control system is working fine. We just have a very slight drift to the left."*

Capcom then asked if they were on the secondary dc-to-dc converter, which Grissom confirmed they were. Capcom also enquired if they were also on the secondary ACME

(Attitude Control and Maneuver Electronics) yaw logic, which they were not, so he instructed Grissom to try that setting. While this conversation was going on between Grissom and the ground, Young continued having trouble with Grissom's blood pressure equipment.

In the post-flight debriefing on the USS *Intrepid*, Grissom commented on the mysterious drifting which would turn *Molly Brown* around 30 to 40 degrees before he realized they were actually moving: "I'd bring it [Gemini] back to zero yaw, and it would drift to the left at a fairly high rate. We tried several procedures to try and stop this, such as switching to the secondary ACME, turned C/Bs off, went through everything you could try, and it still continued to drift." The initial thought on the ground was that it was some sort of mechanical leak and they would be unable to stop it, though Grissom did not turn off the propellant valve. As the flight progressed, this left yaw drift diminished, so much so that by the third and final orbit it was so slight that Grissom stated he could not actually detect it. "We changed to secondary drivers and stayed on them for the rest of the flight. The only recommendation from the ground he would not follow was to recycle the propellant valves on and off. "I didn't see how this could affect it, so I wouldn't do it. That valve was open, and I was going to leave it open," he reported post-flight. He was aware of the drift in HORIZON SCAN and PULSE modes and probably other modes too, but this was masked by doing other things. "[when] I was performing a maneuver, it wouldn't have been apparent," he recorded, noting that this was the only control problem they had during the whole flight. "Everything else worked perfectly," he confirmed.

On the ground, the controllers analyzed the data. They realized that there had been no unusual use of fuel during the first orbit and reasoned, with a high degree of confidence, that it was not a fuel leak that was pushing *Molly Brown* off to the left. The next line of thought was that the heat exchanger, in the process of boiling the water, was dumping it overboard in the direction that would indeed cause a left yaw. Once again, fixes were put in place for subsequent missions. In this case, diverters were installed on the outlets and guide mains of the boiler, so that the required dumping went through the center of gravity to avoid initiating the unwanted rotation.

Now over the Indian Ocean for the first time, the astronauts switched the cooling system over to the radiator. As the radiator cooled, the excess water was boiled for cooling and then switched back to the radiator. This alleviated carrying a significant amount of water for that task, thus lightening the launch mass. This was a lesson learned from Project Mercury flights and the metric that first-orbit Mercury astronauts encountered setting up for orbital flight.

Young was now having difficulty in stowing the unused urine collection devices which had been available for the astronauts to use on the pad or during ascent. Neither had required them, but they still had to be stowed out of the way.

Young: *"I don't know where I'm going to put this."*
Grissom: *"Does it have urine in it?"*
Young: *"No, there isn't anything in it. It's air in it. I'm supposed to fit [it] into the aft food box."*
Grissom: *"Puncture it if it's just air."*
Young: *"Well, that's a thought."*

After removing the launch urine bag, Young had installed the urine nozzle and used the on-orbit urine bag to evaluate the system for the later, much longer flights. In doing so, he also encountered a problem which he warned might occur on longer flights: "I spilled a little urine [which he estimated was about 5 percent of what he passed], not as much as I expected to spill on my first attempt, and cleaned it up with a towel. As far as I am concerned, towels are a must for long duration flights." During the post-flight debriefing, he observed that it was impossible to do anything inside the spacecraft without spilling water, "unless you have time and are extremely careful and lucky." Future crews, he warned, would need plenty of clear up towels because water spillages over a long period of time would get them in a lot of trouble. He found that in using the system, he left some air in the bellows as he tried to evaluate the urine to dump it through the water boiler. "Therefore, I had to open the uriceptical to the cabin so that I could relieve the psi differential and pull the bellows out. There is a lot of procedure involved in using the uriceptical properly," he reported.

Grissom then informed the ground that they had been unable to send the blood pressure reading because, "*the bulb won't fit in the suit hole anymore*." Once again, the ground could not have heard him because two minutes later Cooper asked for the readings.

Cooper: *"We have not received a blood pressure or an oral temp."*
Grissom: *"Roger. I told you the blood pressure bulb won't fit in the hole anymore. I think the 'O' ring is jammed, or something."*

As they awaited a reply, they sent the respiratory measurement and oral temperatures down to the ground. The astronauts explained more about the blood pressure measuring system after the flight. Young explained that they encountered a problem in getting the blood pressure fitting into the suit. "Your blood pressure worked alright," Grissom added, "but I couldn't get the bulb plugged in the hole in my suit. The suit plug would go into the hole, but I couldn't get the blood pressure fitting to go in."

At 49 minutes into the flight, PAO Haney came back on the loop once more to update listeners on the progress of the flight.

PAO Haney: "This is Gemini Control. The *Coastal Sentry* ship in the middle of the Indian Ocean is still in communications with [Grissom]. [The flight] surgeon advises that the data on both pilots is excellent throughout the flight, the respiration and heart rate completely within the normal range. We've updated the computer and within a few minutes the *Coastal Sentry* should lose contact and [then] a few minutes after that our Carnarvon station [Australia], where Astronaut Pete Conrad is located, should be in contact. This is Gemini Control."

Aboard *Molly Brown*, Grissom turned down the cabin lights to complete the RCS plume checks. "A night-side retrofire looking out the window is going to be virtually impossible," Grissom later reported. "You could see the horizon reasonably well through the pitch thrusters, but when the yaw thrusters fire it puts a lot out and just blanks out everything out the window." Despite not having any camera settings, Young took photos of the event through the window. The astronauts reported that the thrusters had fired "just fine," with the plumes appearing as a light-red color with little specks all through them, reminding them of sparks from a fire. Grissom reported that the plumes were bright, but that did not surprise him as they had seen similar, slightly smaller results at the Liquid Test Facility pre-flight.

By GET 50 minutes 27 seconds into the flight, *Molly Brown* was over Australia, where Pete Conrad, the Carnarvon Capcom, tried to make contact with the crew to enquire about the status of onboard systems and whether any of the suggested remedies had solved the yaw problem. Chris Kraft, Mission Director back at the Cape, advised Conrad out at the Australian station that he was completely satisfied with the system performance of Gemini at this time and told Conrad to give the crew a "GO" for their second orbit.

Grissom: *"No. none of the remedies helped and we are 'GO' [here]."*
Conrad: "*Okay. You have a 'GO' from down here for the second orbit."*

The astronauts received more updated parameters of their orbit and were able to synchronize their onboard clocks to that of Mission Control.

Conrad: *"[GET 51:53] MARK! Your clock is synched with all on the ground and your spacecraft elapsed time is synched."*
Grissom: *"Roger, and I believe I see a light from Perth."*

The Perth lights were a local welcome that several of the Mercury astronauts had reported seeing on their solo flights.

As the spacecraft flew over Carnarvon, Young was now having difficulty starting the S-4 blood experiment. This was designed to determine whether chromosome aberrations in human white blood cells were being produced by interaction between radiation and the weightlessness brought on by orbital flight, which could have serious implications for much longer flights. The experiment package was located on the right-hand hatch above Young, with electrical power provided by spacecraft power systems and a single telemetry channel used to monitor the temperature of the package. Young had to initiate the irradiation of the blood samples manually by means of a handle on the package and then stop the process after 20 minutes. This was the only crew input, but the experiment's location caused some frustration. He found it difficult to log the start accurately, as he was having trouble securing the device because the bracketing and clearance dimensions of the experiment were different from the mockup he had trained on in the simulator. This did not please him, as he thought he would not be able to start the experiment at all. "This is the kind of thing that we want to make sure never happens again," Young made clear post-flight. "If an experiment is worth carrying, it's worth operating properly. If not, we should remove it. The same problem was experienced on de-energizing it, because the dimensions were not what they had been all along in the simulator." While he noted that the forces required to operate the experiment were not excessive, it was still frustrating and time consuming to battle with hardware that differed from what they had trained with.

S-4 White Blood Cell Experiment

This experiment, conducted under the auspices of the U.S. Atomic Energy Commission in cooperation with NASA, was designed to irradiate a series of samples of human blood simultaneously in identical experimental devices; the one directly above John Young's seat and another on the ground back at the Cape. About ten days prior to the flight, a team of three biologists, two engineers, a welder and a radiation physicist gathered in a laboratory-shop trailer at Hanger S at the Cape, where they prepared samples for simulations and enough flight-qualified experiment parts to provide adequate back up if required. A few days prior to the mission, three recovery area biologists reported to the primary recovery vessel and the first and second orbit (contingency) recovery vessels to set up the post-flight equipment for the experiment. The experiment had actually begun two days prior to the launch (March 21), when sterile peripheral blood samples were taken from the prime and back up crewmembers, from which short-term cultures were prepared and incubated at 98.6 degrees F (37 degrees C). Further samples were taken nine hours prior to launch from two pre-tested donors and two experimental devices were then assembled and tested. Then, 210 minutes prior to launch, the flight experiment was installed in *Molly Brown* while the ground-controlled experiment device was placed in a controlled-temperature cabinet that was periodically adjusted to replicate the temperature reported from the cabin data of *Molly Brown* throughout the flight. When Young activated the experiment in space, the ground experiment was activated at the same time. [7]

Much of this pass over Australia was spent checking the various telemetry systems and readings, as well as updating their clocks and times for the computer to calculate the various retrofire positions, should this be needed early. The crew had also input the precise data for the first engine burn, which would lower the orbit to a near-circular 100 miles (160.9 km). Grissom finally gave the elapsed time of the blood experiment as 50 minutes and 18 seconds. Pete Conrad then began to read up the next maneuver list to Young, who dutifully copied it down.

Conrad: *"Okay. GMTB 15 43 23. ΔV of 139. Duration of burn – 2 minutes 39 seconds. Your GMTRC 15 55 24. Roll left 55. GMTRB 16 05 28. Roll right 65. GMT 400K 15 58 23. Your maneuver load: 6344257, 0444775, 0533348, 664903.3, 676628.4, 082244.4, 09120.50, 10031.38, 11302.00."*

These official data transmissions were of the critical flight data and engineering 'spacetalk' that did little to enthuse the media about the quality of the exchanges with the spacecraft.

Conrad: *"Your Texas burn will be 48 ft./sec* [14.63 m./sec] *for 73 seconds… Your clocks look good on the ground, and everything is 'GO' here. See you next trip."*

As they moved beyond of the range of Carnarvon and out over the south western Pacific Ocean, back at the Cape, Vice President Hubert Humphrey departed the Gemini Control Center. Together with Dr. Robert Seamans, he went on to visit several other locations on the nearby Merritt Island, where preparations for the huge Apollo Saturn V moon rockets were being conducted, but planned to return to the Gemini Control Center later in the mission.

Meanwhile, up on orbit, Grissom commented on what he was seeing out the window as the thrusters fired.

Grissom: *"On the OAMS thruster check, the fire is red in streaks. When the yaw thrusters fire it definitely wipes out the horizon. [I] can see the horizon all right through the pitch thrusters."*

But his pilot was not looking, because he was too busy with another slight problem to really comprehend what was happening outside.

Young: *“Oh that’s lovely, I wouldn’t believe it if it hadn’t happened.”*
Grissom: *“Huh?... What?”*
Young: *“I got my left shoulder harness tangled up in the back board. Had to turn around to get it out.”*

In the tight confines of his position, this was not easy. Young had released his seat belt and shoulder harness early in the flight and “it seemed everywhere I turned I was bumping my head on the hatch of the spacecraft overhead,” he reported post-flight. His lap-belt restraint was loose practically for the whole flight and he never did ‘sit’ back down in the seat until re-entry. With his helmet pressed against the spacecraft hatch, he found that he got a better view out of the window. Being jammed right up against the hatch meant that he could observe the thruster burns and he later suggested that, during the forthcoming docking flights, the removal of the egress kits from their present location would afford a better eye-level view out of the window, giving the crewman as much room as possible.

Meanwhile, Grissom had noticed that the yaw drift had stopped. At GET 1 hour 1 minute and 36 seconds into the flight, Young checked the OAMS source pressure level and found that it was down to 2,400 psi. Grissom asked if this was OK and Young confirmed that was fine and that they had not used any OAMS fuel. The propellants onboard Gemini were stored in spherical all-welded titanium tanks and their contents were expelled using a pressuring gas (in this case helium which was stored in smaller spherical titanium tanks), which acted upon the outer surface of the bladders located within the tanks and which contained the propellant. Known as the ‘source pressure’ this was stored at a nominal 3,000 psi and its level was displayed on the cabin instrument panel. In the event of a failure of the primary regulator, the crew could manually regulate the system feed pressure by switches and valves. [8] The pilot then did a mains battery check (Gemini 3 did not carry fuel cells due to the short duration of the flight), which also came out fine. However, they were still being distracted by all manner of debris floating around the cabin.

Grissom: *“Look at that thing. I don’t know what we can do with any of the stuff floating around. Do you?”*
Young: *“No, I don’t either. We need a special place to keep that stuff.”*
Grissom: *“I’ll put it in my pocket.”*

As Grissom looked out the window, noting that he could not see many stars, his attention was drawn back to a scanner IGNORE light coming on again. He asked Young if they were losing the gauges again. Young assured him that they were not and that all the power was OK. “*Must have been our scanner, I guess*,” Grissom surmised. The two astronauts then proceeded with a prescribed Cabin Air Recirculation test with the faceplates of their suits closed.

So far, conversations between the astronauts and the ground had largely been confined to typical test pilot speak (as highlighted in the final communications with Carnarvon). This reflected the no-nonsense characters of both astronauts, one of the reasons why they were chosen for this important first test flight which was basically a rundown of the system verifications established on the unmanned missions and ground tests. Consequently, there was very little extraneous conversation noted by the media on the ground.

Young deactivated the blood experiment at GET 70 minutes 18 seconds, after 20 minutes exposure to phosphorus 32 radiation sources. The control experiment on the ground was switched off at the same time. Between the shutdown and separation from the Titan launch vehicle (apart from subsequent burn accelerations) and retrofire, the experiment had remained essentially weightless for around three and one-half hours following irradiation. The crew also noted that the next activation of the sea urchin egg experiment was fast coming up. Completing an RCS plume check, the astronauts reported that thruster fire was quite satisfactory from the thruster's chamber.

Grissom aligned the platform using the Flight Director Indicator (FDI). He thought that the alignment worked quite well and while he found it a little time consuming to keep all the needles nulled, it became pretty obvious to tell when the platform was aligning with the spacecraft. "It's easy to tell when it is aligned, using the window," he explained. Grissom reported that he could determine roll and pitch alignment within a couple of degrees and yaw almost as accurately. However, he did add, "You have to pitch down quite a way to get a better yaw reference, but yaw determination, even at a zero-pitch attitude, is not difficult." After this exercise, Grissom activated the sea urchin experiment again.

As they emerged from the night side, Grissom noted the rapid change in lighting conditions inside the spacecraft.

Grissom: *"It sure lights up all around though, doesn't it?"*
Young: *"Sure does."*
Grissom: *"Okay, we're just about to get it [sunlight] all in one window."*

At GET 1 hour 11 minutes and 32 seconds into the flight, Gordon Cooper at the Cape Mission Control came back into communication via the Canton ground station.

Cooper: *"Roger,* Molly Brown*. Cape Capcom. We're going to have you leave your propellant switch on and do the Texas burn, and we will watch your fuel usage across the States. If it continues, we'll have you turn your propellant switches off then, when you're over the Cape next time, except when you need to use the fuel."*

Grissom repeated the instructions to make sure he understood the plan to leave the propellant switch on for the burn over Texas and then to watch for any leakage afterwards. If there was a leak detected, MCC would command the crew to turn the switches off over the Cape. Grissom informed the ground that they could not tell whether they were using any fuel, to which Cooper replied that the ground was not overly concerned at this time.

Cooper: *"It's just that we'd like to get a handle on what is causing it here… your oxygen pressure is off the high side of the scale. You may have had that switch failure in there. You may have had a telemetry failure in there that failed to the high side."*

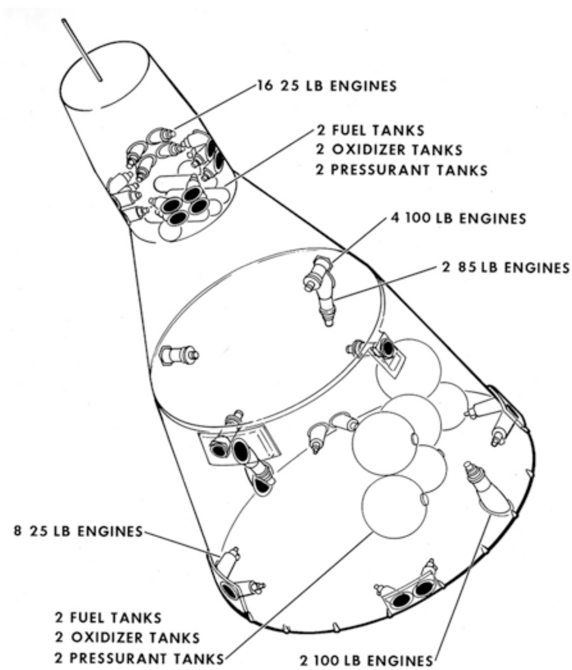
Grissom told Cooper that they had lost one of their primary scanners. Asked to give the helium source pressure they had discussed earlier, Grissom responded with a figure of 2,350 psi. Young suggested that he might be able to get the cabin pressure rate down using the oxygen high rate and by trying manual actuation. He also noted that he had not yet done the suit integrity check. Grissom mused that they had probably driven the oxygen overboard when they used the heater switch, thinking the pressure was down. As they attempted to resolve the problem, the pressure came down and after two minutes it was 'off the peg' and reading a more comfortable 985 BTU with cabin pressure holding at 5.6 instead of the nominal 5.0 to 5.3 psi above ambient.

Their next task was to prepare for the burn over Texas, but once again they were distracted momentarily by the developing sunrise over the Earth's horizon.

Young: *"Here comes the sunrise. Isn't that beautiful?"*
Grissom *"Isn't that pretty? Aren't you going to take any pictur*es*?"*

Young replied that he had not planned to do so on this pass, but he would get the camera out.

Young: "*Yes. The sun's bright, isn't it?... Look at that* [he called out as a camera reel floated by]. *Where do you suppose that came from?... I know you shouldn't let those things float around, but I don't know what to do with them.*"



The system of maneuvering engines positioned around the Gemini spacecraft.

As Grissom prepared for the next burn, Young reported that cabin pressure had climbed back up to off scale as he changed the tape cartridge that recorded onboard communications, noting the said change on the new tape. Young found that it was easier to change the tapes in zero-g than it had been in 1 *g* with suit gloves on, but noted that it was important to ensure that the operation was successful and that the recorder was closed properly to engage the next tape. Had he not engaged the tape correctly? This was not made clear at the time but it was good advice. During the post-flight debriefing, Young offered his opinion of the on-board tape machines. He stated that the tape changing was easy and he never saw a warning light, but he didn't really know if the device was operating correctly, having no clear way of telling. "I guess you take it on faith that the thing is working after you get the top closed," he mused, then added, "I recorded for a short period of time with the top not fully closed. I don't know if it will operate like that or not. I wish we had a separate switch for controlling the recorder, not on the communications control center," he suggested.

At GET 1 hour 23 minutes 38 seconds into the mission, communications were established with the *Rose Knot Victor* (RKV) tracking ship, stationed approximately 800 miles (1,287 km) off the southwest coast of California. The crew immediately reported that the oxygen pressure in the crew compartment had been brought down, but had since climbed back up. The RKV Capcom also confirmed a "GO" for the next orbit and a further update to the maneuver burn times.

After a few minutes of exchanging numerical data for the burn that was planned for GET 1 hour 28 minutes 13 seconds, Grissom reported that they were in "*good shape*." Then, a few seconds later, the RKV Capcom informed Grissom of unplanned thruster firings.

Capcom: *"*Molly Brown*, RKV. I'm getting an indication of OAMS thruster forward-firing. I have negative OAMS yaw firing on the ground [plan]."*

Grissom: "*We're not doing any firing. We're not even in MANEUVER and ATTITUDE [modes] and [we] haven't touched the handle.*"

Capcom: *"Roger."*

Clearly, being told that data was recording a thruster firing when he knew they had not input any such command had spooked Grissom for a moment and he was unclear where such information had come from, since he had not touched the controls. This was a strange broadcast, as nothing more was said of the apparent error prior to the burn maneuver over Texas a few minutes later. The official Gemini 3 post-flight mission report recorded, under the Orbital Attitude and Maneuvering System section, that "No malfunctions, failures or anomalies [of the OAMS] are known to have occurred during the flight." This suggests there was an [unreported?] error in the ground equipment at that point, as neither Grissom or Young noted any malfunction onboard *Molly Brown* on the [released] air-to-ground commentary or in post-flight reports.

As *Molly Brown* passed from RKV to Guaymas station, the crew's attention was once more focused on the view out the window.

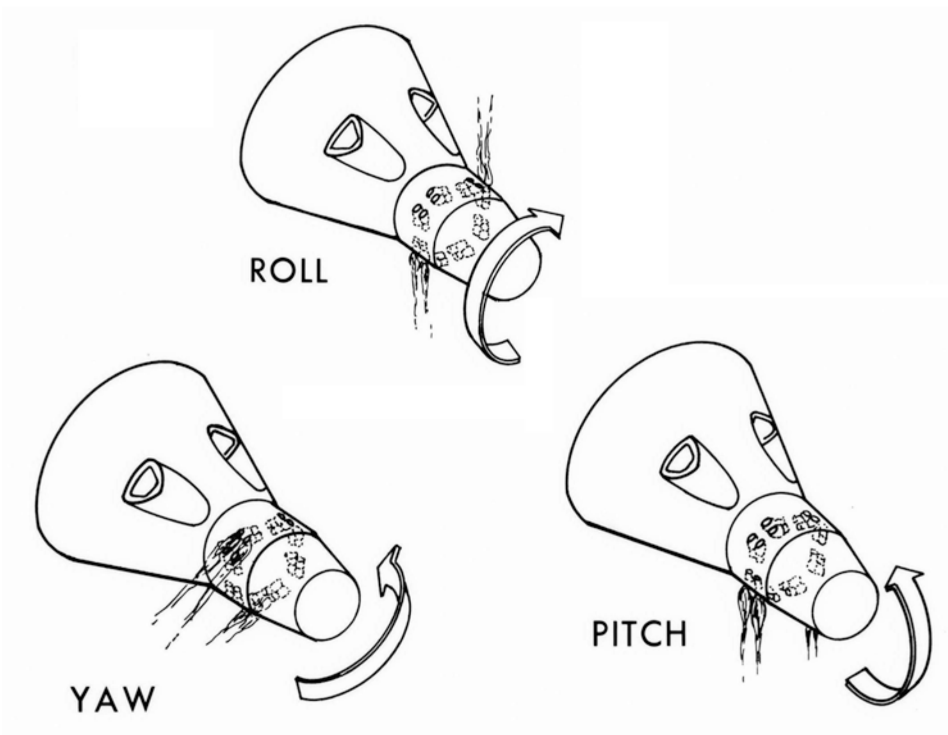
Young: *"Outstanding! I see the whole of Mexico… I wonder what area of Mexico it is?"*

Meanwhile, with everything focused on the mission in progress, it was reported that over the eastern Atlantic, some 1,200 to 1,500 miles (1,930 to 2,413.5 km) off the north-west coast of Africa, one of the four-engine C-54 Air Rescue Service planes had developed engine trouble in one engine and had feathered a second. It was being diverted to Las Palmas airport in the Canary Islands, a flight of approximately two hours. This aircraft was one of several stationed around the world to support a possible aborted launch, or an emergency re-entry and landing of Gemini 3 before its planned de-orbit burn at the end of the mission.

Back on *Molly Brown*, one of the crew's tasks was to attempt some tracking experiments over the western seaboard, but it was becoming clear this was not going to be easy with the weather closing in.

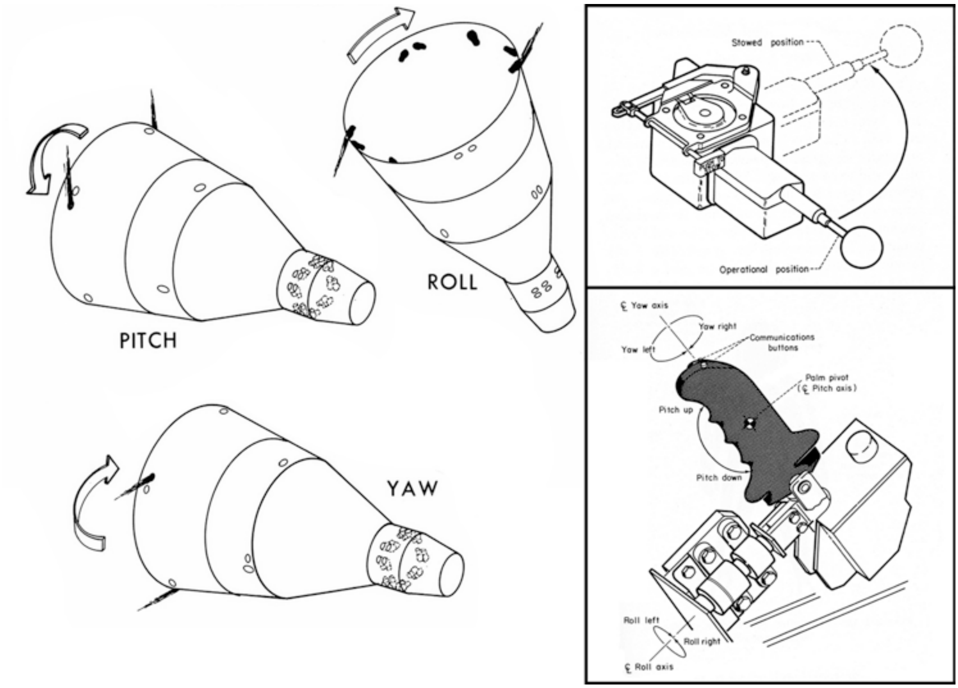
Grissom: "*It's* [the weather] *pretty well clobbered, isn't it?*"
Young: "*Yes.*"
Grissom: *"We're going to have a hard time with that tracking task."*
Young: *"Can you see anything up north there?"*
Grissom: "*I never got the chance to look for the Salton Sea, but I think we can see up that way. Nothing but high cirrus.*"[4]
Young: [looking the other way] *"Oh man! Oh man, you can see all the way across Mexico!"*
Grissom: *"You must have it clear down there, huh?"*
Young: *"Yes, it's clear down south here."*

By now, the communications link on the ground had passed from Guaymas to Texas, who reported that they were standing by for the planned maneuver on Gemini 3. When the announcement was made that *Molly Brown* was flying over Texas at the end of the first orbit, everyone in Young's house suddenly stopped talking, marveling at the fact that Grissom and Young had already completed almost a third of their mission.



Functions of the Reaction Control System located in the nose section of the Gemini spacecraft.

[4] The Salton Sea is a shallow saline rift lake directly on the San Andreas Fault line and is located in the Californian Imperial and Coachella Valleys.



The response of the spacecraft to the Attitude Thrust Control system in the Adapter Section at the aft of the spacecraft. [Inset bottom] Gemini attitude control handle from the central console. [Inset top] Gemini translation-maneuver hand control.

MOVING GEMINI IN ORBIT

To facilitate the movement of Gemini in orbit, a system of 32 bi-propellant liquid-rocket thrust chambers were arranged in three independent rings. Each ring consisted of eight 25-lb. (11.34 kg) thruster units that were arranged to fire in parallel pairs, for either yaw (turn left or turn right) or pitch (nose up and nose down) control, as well as in differential (varying depending upon circumstances) for roll (to the left or right).

Two of these rings were in the cylindrical Re-entry Control System Section located in front of the pressurized crew compartment and each included dedicated propellant and pressurization tankage, valves and plumbing lines. This separation was part of the redundancy in the spacecraft and thus essential to crew safety. Should one system fail, the other could continue to complete the required tasks. This dual system was called the Re-entry Control System (or RCS) and was employed only during the retrograde and re-entry phases at the end of the mission.

The third ring of attitude control thrusters was the primary system used for orbital maneuvering during a mission. These eight thrusters were arranged differently, at the base of the Adapter Module. There were four 100-lb. (45.35 kg) thrust units which were directed through the spacecraft’s center of gravity and used for lateral (sideways, left or right) and vertical (up or down) impulses. Another pair of 100-lb.

(45.35 kg) thrusters was located at the base of the Equipment Adapter Section to provide forward thrust, while a pair of smaller 85-lb. (38.55 kg) thrusters to provide reverse thrust were located either side of the Adapter, near to the Re-entry Module attachment section. These faced forward and were canted slightly outboard to prevent contamination of the crew compartment windows or target vehicle.

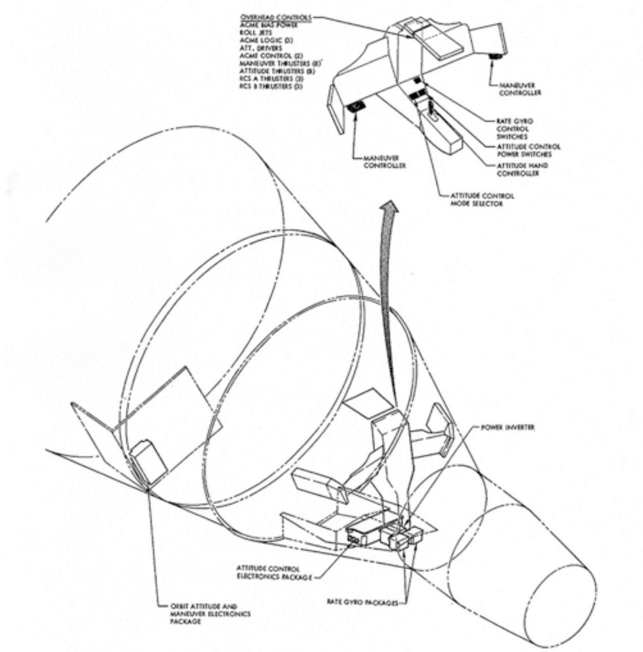
The system located in the Adapter Module was known as the Orbital Attitude and Maneuvering System (OAMS). This system shared a common propellant supply and in the event of a single thruster failure, that thruster could be isolated leaving the other of the pair to function. This was not a totally redundant system, as mission safety was not an issue in their use, but due to the extreme weight penalties that would be incurred, a truly redundant system was not possible in the Gemini design.

The thrust chambers were cooled ablatively by installing ceramic inserts in the throat section of each thruster, with separate valves for fuel and oxidizer. Both the RCS and OAMS systems used the same propellant, simplifying the plumbing requirements. The oxidizer was nitrogen tetroxide (N_2O_4) and the fuel was monomethyl hydrazine ($N_2H_3CH_3$). This propellant was pressure-fed from bladder-type tanks through the associated plumbing to the relevant thrust chamber. Each of the RCS systems had 33 lbs. (14.96 kg) of propellant capacity, which was deemed sufficient to provide both retrograde and re-entry requirements, with one system again offering redundancy for the safety of the crew. The maximum propellant value for the OAMS tanks on a rendezvous and docking mission was 700 lbs. (317.5 kg), sufficient to support the attitude control maneuvers for a typical rendezvous and docking mission, plus a 700 ft./sec (213.36 m/sec) maneuvering velocity increment. However, on non-rendezvous (such as Gemini 3) and long duration missions (Gemini 4, 5 and 7), where maneuverability was not a priority, smaller OAMS tanks were fitted to the spacecraft. This was primarily to save weight, but also to allow for extra oxygen and (on the later missions) fuel cell reactants to be included to support the extended duration objectives.

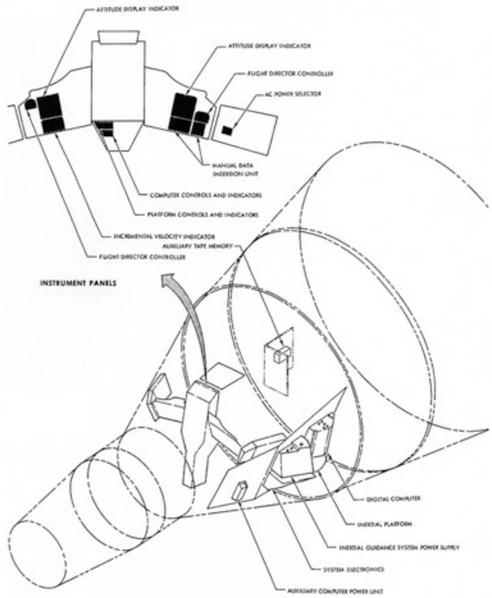
The astronauts could input commands to move Gemini using either the attitude control or maneuver control handle. These inputs were then processed throughout the Attitude Control and Maneuver Electronics (ACME), which included the relevant logic circuits to select the appropriate thruster valves for the requested maneuver. As Gemini moved, its dynamics were sensed by a combination of the rate gyros, the horizon scanners and the Inertial Measurement Unit (IMU) in the Inertial Guidance System (and during rendezvous missions by the spacecraft's radar system). The data from these sensing units was then displayed on the panel in front of the Command Pilot. Equally, depending upon the mode of control selected, the outputs from the sensors could be fed directly into the ACME to provide automatic or mixed-model control modes. During re-entry attitude control, a direct mode was available in which the signals could be fed directly from the control stick in the astronaut's hands to the thruster chamber solenoid valves.

The astronaut had three different manual attitude control modes available to him: RATE COMMAND, SINGLE PULSE and DIRECT; plus two automatic modes, either ORBITAL or REENTRY. These modes will be explained further during subsequent titles in this series covering the rendezvous and docking missions. There were a number of redundancies available in these systems. A range of crew-selectable backup units were available for the horizon scanner, the rate gyros and attitude control electronics. Together with the previously mentioned redundancy in the re-entry attitude control thrusters and redundant control signals through the control handle, the crew had access to a wide range of primary, backup and contingency options during their mission, though of course they hoped to rely solely on the primary systems from launch to landing.

Primary contractor McDonnell was responsible for the overall development of the concept, its definition and the final integration of the guidance and control system in Gemini. Sub-contractors included Minneapolis-Honeywell in Minneapolis for the ACME and rate gyro systems; and Minneapolis-Honeywell in St. Petersburg, Florida for the Inertial Measurement Unit. International Business Machines (IBM) provided the spacecraft’s computer and Delta-V indicator. They also had responsibility for the integration of the overall Inertial Guidance System (IGS) in each spacecraft, as well as conducting analytical studies in computer programming in support of mission planning. Advanced Technology Laboratories provided the horizon sensors, while Westinghouse supplied the spacecraft’s radar and range rate display. Lear-Siegler were contracted to supply the attitude and rate indicator and Rocketdyne provided the spacecraft’s thruster system.



Attitude Control and Maneuver Electronics.



Inertial Guidance System.

At GET 1 hour 33 minutes, Gemini 3’s engines burst into life, with Young reporting that the engines seemed to be “*firing good.*” Capcom confirmed the OAMS firing via the Texas station. Young then noticed “*a bolt stuck up against the instrument panel*,” as loose objects, normally floating around the cabin, were pinned by the *g*-forces of the burn.

To move Gemini, Grissom had the attitude control handle or the maneuver control handle at his disposal. The attitude control handle was on the central console between the two astronauts. Designed for either astronaut to use, this controller was used to control Gemini’s attitude and rate manually in three axes and was operated by simple wrist articulation and by pivoting the palm. Its design included a spring-loaded device that increased resistance as the handle was moved further away from neutral. The maneuver control handle for Grissom was at the lower left on his main control panel. Young had a similar auxiliary device under his switch/circuit breaker panel to his right and both handled translational control. Each of the two controllers featured centering springs and six switches, one for initiating movement of the spacecraft around each of the six directions along three major axes. Movement of the handle in any of these directions initiated the relevant spacecraft movement in that desired direction.

The inputs through the maneuver control handle were then processed by means of the Attitude Control and Maneuver Electronics (ACME) that contained the logic circuitry required to initiate the correct thruster valve. The Orbital Attitude and Maneuvering

System (OAMS), which allowed Grissom and Young to claim the first maneuvers in orbit, was a thruster chamber assembly group of 16 fixed engines operating at specific thrust levels. Eight of the engines developed about 25 lbs. (11.3 kg) of thrust, two developed about 85 lbs. (38.6 kg) and the other six about 100 lbs. (45.4 kg). Pitch, roll and yaw were induced by firing the 25 lbs. (11.3 kg) thrusters in pairs. For lateral, vertical and forward movement, the 100 lb. (45.4 kg) engines were used. Rearward motion was courtesy of the two 85 lb. (38.6 kg) engines.[5]

For *Molly Brown's* first maneuver, Grissom opted for the twin forward-firing thrusters in the RATE command mode, where pitch, yaw and roll rate gyro outputs were computed with the position of the controller to produce the attitude rates proportional to the movement of the controller. With the attitude controller in his right hand, Grissom could command the movement of his spacecraft by pivoting his palm to input a rotary movement of the handle about a transverse pitch axis (nose up or nose down). Rotatory displacement in either a clockwise or counterclockwise direction in a traverse plane instigated a similar movement about the spacecraft roll axis (roll to the left or roll to the right). Moving the controller in a clockwise or counterclockwise rotation about its longitudinal axis commanded movement in the yaw axis (turn to the left or turn to the right).

Grissom commented that the engines seemed "*to burp a lot, don't they? That may be attitude control thrusters though. [That's] probably what it is*." After a full minute of the burn, another MARK was recorded, with a velocity of 7 ft./sec (2.133 m/sec) yet to be achieved. Grissom wanted to know what they had achieved before the burn was over, asking Young to give him a MARK and a "*burn down*" to cut off. The spacecraft's forward-firing thrusters, numbers 11 and 12, ignited for about 75 seconds, successfully demonstrating the maneuvering capability of the new spacecraft. *Molly Brown* shifted its orbit and in doing so created spaceflight history, with Gemini 3 becoming the first spacecraft to maneuver in orbit, essentially circularizing it within two miles of the planned parameters and thus achieving one of the key objectives of the Gemini program.

Grissom noted after the flight that he could not hear the forward-firing thrusters during the burn, which was disconcerting because was able to hear the attitude thrusters. They were similar to what they had experienced in the simulator, but not quite so loud, "But you definitely hear them," he said. "If the attitude thrusters are not firing, you think you [will] stop translating. [But] You can tell you're still translating by the debris drifting forward or aft in the cockpit."

After the burn was completed, Grissom reported the data to the ground.

Grissom: *"As we started to burn, my IVIs read 51 ft./sec and we burned them down to a place when they read 2 ft./sec… Propellant quantity is 65 percent."*
Young: *"Hey, we're in good shape."*
Grissom: *"Yes."*

The IVIs to which Grissom was referring were the Incremental Velocity Indicators, located in front of him on the left-hand control panel and which included three counters

[5] Further details of the Gemini maneuvering system will be included in the Gemini 6 and 8 titles in this series.

that displayed velocity increments along the axes of *Molly Brown*. The data was obtained from the spacecraft computer and displayed to the astronaut in decimal format, with a measurement of 1 ft./sec (0.305 m/sec). The display featured nine digital wheels, capable of indicating a range of 000 to 999 ft./sec in each of the three axes. There were also six lights that indicated the direction in which the astronaut should apply the corrective thrust, with movement of the hand controller corresponding to symbols in those lights. The astronaut could set the counters manually, or they could be calibrated by the computer automatically. This device was used to provide display and countdown of any insertion velocity corrections during the ascent to orbit; displays of catch up maneuver Delta V (on later flights it would show the pilot a display of rendezvous Delta V); and a display of velocity change during the retrograde from orbit. [9]

During the post-flight debriefing a few hours after the flight, Young noted that he had the feeling of being too rushed throughout this first part of the flight plan. "I really believe that on a long mission the flight plan should be set up so that the crew will not be so rushed and also not be busy over the primary stations. Everybody wants the crew to report to the primary stations. This would be fine if they just gave reports over the station," he noted. Aboard *Molly Brown* on this first manned mission, however, they were particularly busy and sequencing their GMT clocks with the ground seemed particularly troublesome. "This is typical of the kind of procedures that we must set up in order to have this [communication] range-spacecraft interface [as an] operational-type working relationship." Though he did recognize that this would develop with time and more input from the crew, he stressed this was an important lesson to learn from Gemini 3.

At 1 hour 35 minutes 27 seconds into the mission, Gemini 3 once again came into range of Gordon Cooper in Mission Control at the Cape. The first orbit of *Molly Brown* had been completed successfully and the second orbit was underway.

References

1. *GT-3 Flight Crew Technical Debriefing*, March 24, 1965 aboard USS *Intrepid*, released by NASA as Gemini Working Paper No. 5025, dated June 3, 1965.
2. *GT-3 Flight Crew Self-Debrief*, USS *Intrepid*, March 23, 1965, NASA Program Gemini Working Paper No. 5026, June 3, 1965.
3. Crew self-debrief, Young, March 23, 1965.
4. All Air-to-Ground extracts from Gemini 3 are sourced from the *Composite Air-To-Ground Onboard Voice Tape Transcript of the GT-3 Mission*, NASA MSC, April 1965.
5. Reference 1, pp. 4-3 to 4-4.
6. Unofficial transcript of the Gemini Titan 3 mission, Paul Haney, PAO, March 23, 1965.
7. Manned Space Flight Experiment Symposium, Gemini Mission III and IV, at the Auditorium of the Museum of Natural History, Washington D.C., October 18-19, 1965, NASA, Chapter 14, Experiment S-4, Zero-g and Radiation on Blood During Gemini III, pp. 217-233.
8. *Project Gemini, A Technical Summary*, P.W. Malik and G.A. Souris, prepared by McDonnell Douglas Corporation for NASA MSC, June 1968. NASA Contractor Report CR-1106, pp. 141-145.

9. **Press Reference Book, Gemini Space Craft**, McDonnell Aircraft Corporation External Relations Division, reprint and update August 30, 1966.

In addition, in the reporting of the orbital flight of Gemini 3, frequent reference was made to the official post-flight Gemini 3 Mission Report (MSC-G-R-65-2, April 1965) throughout this and the following two chapters.

7

Molly Brown "performing nicely"

Oh man! I'll tell you,
I need some of these missions where
I can look out of the window.
I haven't looked out of this window
a second and a half. It's beautiful.
John Young, during the second orbit of Gemini 3.

At the start of the second orbit, as they were flying over the Cape for the first time, Capcom Gordon Cooper asked the crew to dump the data from the onboard tape recorder and requested an update on their OAMS levels and status.

Cooper: *"Okay* Molly Brown. *Looks like your OAMS has leveled out before your burn. Can you give us an OAMS source pressure and temp again now?"*

Young: *"Roger. Source pressure is 2050, temperature is 56."*

Cooper: *"Roger. It looks like that pressure switch on that O_2 is failed. You'd probably better bring that O_2 heater from AUTOMATIC to OFF and then manually control the temp from then on – the pressure from then on"*

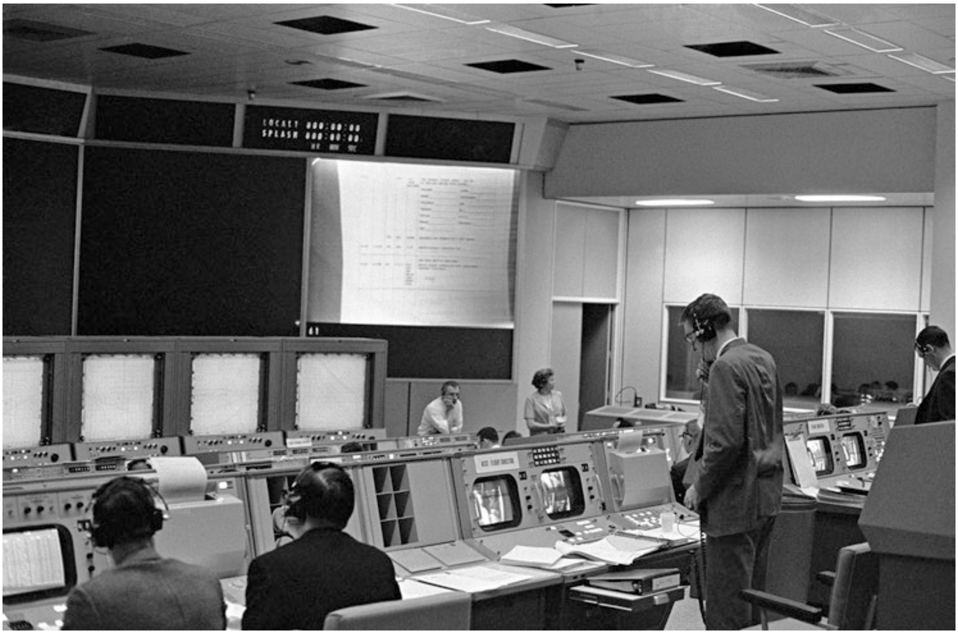
Cooper then gave them a time at which they were expected to be nearest to the booster they had separated from over 90 minutes before. It was ahead of them and in a slightly higher orbit, but they might be able to see it.

Cooper: *"02 [hrs] + 08 [min] + 52 [sec GET] [The Titan stage] will be dead ahead at an elevation of plus 80 degrees at [a distance of] 190 miles [305.71 km]. This will be just prior to darkness. It should be very bright. Proceed to see if you can rendezvous."*

Though not a primary objective on this flight, this would be a useful exercise in preparation for the forthcoming docking mission with Agena that was planned for Gemini 6 later that year. As mentioned, a rendezvous and docking with an unmanned Agena was one of the key objectives of the Gemini program in preparation for the Apollo docking

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_7

operations, but there had not been any rendezvous in space between a manned spacecraft and a target prior to this suggestion.[1]



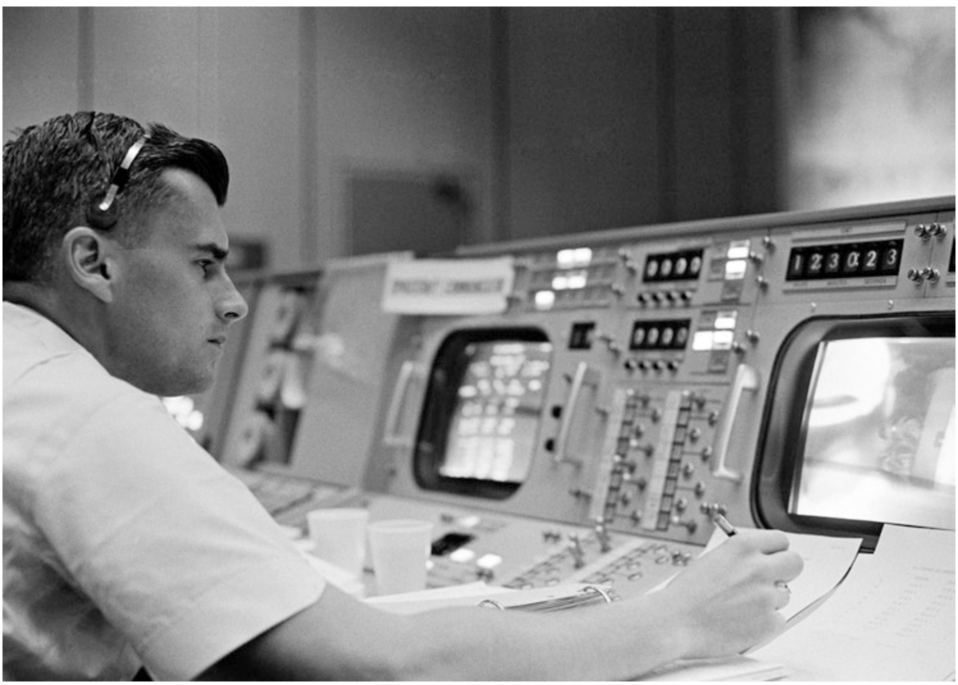
While the main control room for Gemini 3 was at the Cape, there was a team of controllers at the new MCC-H monitoring events real-time in preparation for Gemini 4 in June, when primary control of the mission would shift from the Cape to Houston once it cleared the tower at the Cape.

Cooper then asked the crew if they had managed to complete their experiments during their first orbit, which they confirmed that they had. Everything looked good from the data on the ground. This was followed by the downloads of the blood pressure data, although Young had to send his reading a second time, with Cooper joking that he was just checking if Young was still breathing.

Cooper asked them if the view was as good as on his own Mercury flight, which he recalled was, "*pretty spectacular.*" Grissom, experiencing orbital flight for the first time, replied, "*Yeah, it really is. It really is!* [But] *we didn't get to see much of the States though* [due to too much cloud cover]."

[1] In 1962 and again in 1963, the Soviets had launched two pairs of Vostok spacecraft into similar orbits, but they had no capacity to maneuver or rendezvous. It was simply a case of timing the launch of the second spacecraft to ensure that it would arrive into a close orbit with the first spacecraft for at least the first day. Despite Soviet claims of a space rendezvous first, these were more accurately dual flights rather than pure rendezvous experiments.

Flight Director John Hodge (left) of the Flight Control Division, Glynn S. Lunney (standing left), chief of the Flight Dynamics Branch, Flight Control Division, and James W. Beach, assistant flight director for Gemini 3, are shown in MCC-Houston during the mission.



Astronaut Roger B. Chaffee sits at the Capcom console, a flight controller position that was traditionally occupied (in most instances) by serving astronauts for over 50 years.

After the flight, Grissom explained a problem with his 8-ball indication: "Shortly after the start of the second orbit, I noticed that the 8-ball was not in alignment with my view of the horizon. I was conducting a check of the horizon scanners, during which the entire horizon scanner band is exposed to the sun. I aligned the platform with the horizon [automatic pitch, roll and yaw attitude control to the inertial platform reference]. However, upon going to ORBIT rate, the 8-ball immediately started to drift off in roll. I believe this error was much greater than what could have occurred as a result of an error in alignment in the yaw axis. In a couple of instances, the 8-ball was in error as much as 25 degrees." This error, together with undetermined yaw drift and the apparent inadvertent thrusting in the wrong direction that occurred in the HORIZON SCAN mode each time the scanner IGNORE light illuminated, resulted in skepticism as to proper platform alignment operation through most of the flight. [1]

Grissom continued: "The horizon scanner control mode worked fine. The only thing that is bad about that is that it should shut off altogether when the scanners get an IGNORE signal and leave you right where you are and not throw you out of attitude." Generally, Grissom was happy with the system, but found it strange how the IGNORE light came on and off. When the horizon scanners received an IGNORE signal they would initiate a pitch down. Grissom would then regain control and stabilize and then wait a few seconds for the light to go out. Sometimes it did, but other times it did not, so he would switch to the backup system to extinguish the light. Everything would work fine for an hour, then the light would come on again and the same thing would happen, forcing him to switch back to the primary system for the next hour. He said that he did not want to ignore the light and just drift around, as it kept accelerating the spacecraft all the time. He wanted to find out how all the systems worked on the spacecraft first, retaining control at a known attitude. He realized that if the 8-ball attitude control was lost he needed to know what all his important attitudes looked like while the ball was there for reference.

The ORBIT RATE mode worked fine until the second night time. They first noticed a problem when they prepared for a horizon scanner check, yawing around 180 degrees. Grissom noted that the ball was not looking directly at the 90 degrees point, with the astronaut noting they were between 12 to 15 degrees off in attitude and above the horizon. As Grissom tried to correct the error, Young thought his commander was rolling the spacecraft one way and then the other. "I was looking out of the window at the horizon and thinking, 'Boy, that's nice.' It surely was way off." Grissom thought this was a problem, especially as they were going into the night pass: "That's a black night side there. There's not a thing you can see." Young added "No stars you can recognize." Grissom was therefore focused on platform alignment, progressing through the prescribed tests and correcting the roll when the 8-ball started to wander.

The attitude 8-ball was chosen for Gemini as it offered a simple method of using the information from the positions of the gimbals from a stable platform as an all-attitude display. The sphere offered a clear, all-attitude display by means of mutual interaction of the axes, which was a significant improvement over the separate axis display used in Mercury.

On board *Molly Brown,* the 8-ball error turned out to be a procedural problem. In the first orbit, Grissom had selected a mode to align his inertial platform, but post-flight analysis revealed that he had not been not given enough time to align the yaw axis perfectly during pre-flight briefings. Trying not to confuse the reporters, Chuck Mathews explained the issue during a press briefing after the flight. "The horizon sensors sense pitch and roll attitude and this is what enables you to level the platform in pitch and roll, and then you align [the platform] in yaw after you've got pitch and roll all lined up." He explained that it took much longer to align in yaw and in looking at the data from Gemini 3, it was found that Grissom did not have enough time to do so. In correcting his 8-ball on *Molly Brown*, even when he "caged the platform," Grissom inadvertently rolled it 7 degrees further than he planned, as the 8-ball was not serving as an accurate reference for him. It was already locked up and was making him start with a larger error than he thought. It was later determined that ten minutes should be allocated to aligning the platform rather than the five minutes Grissom had available.

> PAO Haney: "This is Gemini Control We are one hour and 48 minutes into the flight of Gemini 3 spacecraft now approaching the northwest coast of Africa."

Haney went on to explain that the Mission Director Chris Kraft was completely satisfied with the onboard systems after a single orbit. During Project Mercury, it had also taken about an orbit to "get all the systems shaken down." The Gemini 3 crew were advised to look for their booster, the second stage of the Titan II, which received the orbital designation of 1965-24B. The pilots would yaw around to look for the stage over the Indian Ocean. They would be in the dark but the booster would be in light, some 20 miles (32.18 km) above and behind them.

Taking a bite in orbit

Grissom then asked Young whether he wanted his first meal package for the food evaluation experiments.

> Young: *"Hot dog! Good old food."*

As Grissom passed the food packages, he asked for a drink of juice when Young was done. When not in use, the water dispenser (used to rehydrate the food) was stowed out of the way up and between the two seats, behind the astronauts on the aft bulkhead of the crew compartment. As they stowed it this time, they noticed the increased O_2 rate.

> Grissom: *"The oxygen still hasn't come off the peg."*
> Young: *"I'll tell you, boy. It poses a serious problem with the O_2 High Rate bit…* [then, asking Grissom] *Is your window foggy, or is it just the angle I'm looking at?"*
> Grissom: *"It looks like it's something on the side. I don't know what it is."*

At this point, at GET 1 hour 49 minutes, the Canary Islands came back into contact with *Molly Brown* to confirm that all systems were "GO" on the ground. Grissom responded that all was "GO" onboard as well, as they completed their alignment check. Later, the Capcom updated the crew on their orbital parameters after their first OAMS burn, confirming the revised orbit as 85.6 by 92.6 miles (137.73 by 149.99 km).

During the post-flight debriefings, Young commented on the use of the Manual Data Insertion Unit (MDU) and on checking the ground-inserted orbital parameters. The astronaut found it quite easy to check the data and backup parameters without actually inputting them, noting, "I don't really see the need for [manual input] if this thing works like it's supposed to. It surely is a lot easier when you send it up from the ground than having to sit there and punch all those buttons, which is going to take 3 to 4 minutes anyway, even if you do it as fast as you can." Young commented that once they had confidence that the DCS had accepted the first load and it was correct, he did not see that it was necessary to recheck the computer every time. He did suggest that computer parameters should be referenced to Greenwich Mean Time (GMT, in England) at the point of lift-off, so that on a nominal mission a comparison would be performed between the insertion parameters and onboard data. They could not do this on *Molly Brown* "because the Goddard axes are different than the ones MCC used for initial update," Young explained. He suggested that this should be corrected for future flights.

It was now time for Young to evaluate the official food and waste systems, but Grissom got a surprise when he was offered a rye bread and corned beef sandwich by his colleague. From the air-to-ground transcripts, the exchange went like this:

Grissom:	*"What is it?"*
Young:	*"Corned beef sandwich"*
Grissom:	*"Where did it come from?"*
Young:	*"I brought it with me. Let's see how it tastes. Smells, doesn't it?"*
Grissom:	*"Yes, it's breaking up. I'm going to stick it in my pocket."*
Young:	*"Is it?... It was a thought anyway… not a very good one."*
Grissom	*"Yep. Pretty good, though, if it would just hold together."*
Young:	*"Want some chicken leg?"* [meaning the official chicken bites]
Grissom:	*"No, you can handle that."*

Grissom later wrote that if he hadn't been floating above his couch, he would have fallen off it when the sandwich appeared. He was never a fan of the reconstituted space food, which in those early days may have been nutritional but was anything but palatable. He took one bite of the sandwich, which he thought, "tasted pretty good," but it immediately started to crumble and bits of it started floating about the cabin. This caused some concern, "so I shoved it in my left knee pocket." Young then started his official food evaluation experiment. [2] Young finally explained about the sandwich incident in his 2012 memoirs. [3] The sandwich had been made at Wolfie's delicatessen, located on North Atlantic Avenue at Cocoa Beach near the Cape. Knowing that the crew were to evaluate the space food to be used on the longer flights – and given their disdain for most of it – the backup command pilot, Wally Schirra, ever the prankster, purchased the sandwich and gave it to Young on the morning of the launch. Young put it in the pocket of his space suit and smuggled it onboard, without anyone knowing. He never thought it was a big deal, which it wasn't on the flight but turned out to be so afterwards.

After passing over the Canaries, Young began the official food and waste evaluation, which he continued until they flew over Carnarvon, Australia. In his post-flight debriefing, Young suggested improvements to the packaging, such as locating the check valve closer to the end to alleviate the use of scissors to cut the sleeve and open the valve. He also found that one of the germicidal pills floated out of the package. He never cut it loose, it just became detached. The drinking water facility was deemed satisfactory, including using the pressure-off drinking valve configuration on the flight to drink from and reconstitute the food, while the blood pressure bulb worked adequately to pressurize the drinking water tank after they had splashed down.

A selection of the food packages aboard Gemini 3. These included dehydrated beef pot roast, bacon and egg bites, toasted bread cubes, orange juice and a wet wipe. On the left, water is being injected into a pouch to rehydrate the food for consumption.

For the food evaluation, Young said that he had left the Brownies sealed, as had been agreed pre-flight because the of the oil in them, but he reconstituted some of the apple juice and grape juice, which worked well and he could consume it shortly afterwards. He did note that he found it difficult to get the feeder tube out to use while wearing the spacesuit glove, but that it was possible. He was not in favor of the chicken bites, however: "The chicken bites were just as I always remember chicken bites – just barely edible and difficult to get out of the package. If you make a wrong move, you are probably going to have a lot of crumbly chicken bites floating around the cockpit."

Once the food had been consumed, Young came up against a new problem that would require more work for the longer missions, namely what to do with the near-empty food packaging. He noted that any juice left in the used pouches floated around the inside edges of the container, even though it was sealed. Over time, the juice could quite easily seep out. Young suggested adding a type of seal to the end of the packages to prevent food seepage. He also proposed that each flight crew should "eat as much of every meal as they can because there is no place to put it." He considered the aft waste containers to be "worthless" and that if crews were going to spend a large amount of time in orbit (especially on Gemini) then a large garbage container would be needed. Having all the packaging floating around was not helpful, but the storage for it all was inadequate. "I suppose that the food reconstitution is adequate for a mission where a guy has enough time to do it. And I recommend we always allow adequate time," he suggested for future mission planning.

When you have to go

Having completed the food and water evaluation, Young used the urine nozzle for the second time and this time it worked better, though he thought that operating the nozzle would take a lot of training, to learn to position it properly and use it. He did not try urinating into a flushing nozzle, which would have directly disposed of the liquid overboard, as he felt "that might have been unpleasant." Though it would prevent spillage inside and would get rid of the liquid promptly, it needed time to be properly evaluated. He thought that using it was a tricky procedure and perhaps a better way to solve the problem should be devised. The crew should not have to worry about urinating too fast or too slow, or the joy of dealing with any spillage inside the spacecraft, he felt. Thinking of the teamwork of other Gemini astronauts, Young generously decided that he would "leave that for Ed White and Jim McDivitt to evaluate [on Gemini 4]."

When asked if he had simulated the defecation procedure for the solid waste, Young confirmed that "I simulated the procedures all right," meaning it was not a simulation. He added, "The bag works – I don't know what to say about it." Defecating in zero-g was always expected to be messy and indeed it was, with no method of controlling toilet paper. The other problem was that the feces just floated at the top of the waste bag and was difficult to get to the bottom. Young also stated that it took all his strength to break the bactericide, that it did not work properly and that he had no time to work on it. He thought that it was a challenge they could learn to live with but added, quite clearly, "Over a long period of time the moist bowel movement is going to be a darn mess." The Environmental Control System (ECS) did remove any odors and Young used a cleaning rag to clean himself with, suggesting that more should be made available for this purpose. He actually ended up with feces on his glove at one point, which he needed to clean up with an ungloved hand and wipes.

During the post-flight debriefing, he expanded upon his report about using the defecation system on Gemini. It was not the most glamorous part of a flight into space, especially in the tight confines of Gemini with your colleague sitting just inches away, but on long flights this would be an essential skill to master. Young added "I won't describe [that], except to say that I didn't have enough time to do that evaluation justice." He added that he was unable to evaluate the finger receptacle on the defecation glove properly and suggested that there had to be a better way to handle the paper used during the process. Young's evaluation made it clear that no matter what a crewmember tried to do, they would have to live with the fact that "going to the bathroom in zero-g is a mess. There is nothing to help make the feces go down in the bag, which is what I keep telling everybody. This finger on the bag is a great idea, but if you have a wet bowel movement, all you will do with the finger is plaster the feces all over your rear end. I don't know what we can do about it, except be very careful and practice, practice, practice."

Other food and waste evaluations were also tried with gloves on. Young had to make an in-flight adjustment to his suit, with Grissom warning him to be careful that he did not puncture the pressure garment, by cutting the center strap between the two zippers to make the use of the urine receptacle more comfortable, something he recommended for all future suits. Repositioning the zipper to a higher position would also help future crews, he thought.

Young also suggested that adequate time should be inserted into the flight plan on future missions to allow for the preparation of meals, eating and waste disposal, so that the crew could remain healthy in their semi-closed environment. As Gemini 3 was such a short flight, Young was not able to evaluate the systems adequately.

Over Africa's Kano station, telemetry and other data was recorded and, based on radar data, new orbital parameters were determined which showed a perigee of 97 miles (156 km) and apogee of 105 miles (168.94 km).

> PAO Haney: "A reduction in the size of the apogee of approximately 35 miles (56.31 km), a truly historic maneuver. Earlier our apogee had been 100 statute miles by 140 statute miles (160.90 by 225.26 km). At the same time, we reduced the period of the orbit by approximately one-third of a second to a new orbital period of 87 minutes and two-thirds of a second. That is an approximation, but it is close. This is Gemini Control."

Grissom's concentration levels were evident throughout the flight and when Young sometimes let out an "*Oh, No!*" Grissom would instinctively reply with "*What? What did you drop?*" (a natural response to letting go of something, which on Earth would fall, but in space, of course, did not). This time it was Young letting go of a food bag which floated away. Grissom joked that Young was "*a noisy eater,*" but both marveled at food bags twirling in zero-g. Grissom asked his colleague to save him some of the apple sauce if he did not eat it all. Young noted that it was getting difficult to squeeze the sauce out of the packaging, to which Grissom replied, "*If we had some pork chops to go with it, we'd be all right.*"

Flying backwards and 'upside down'

As Young evaluated the food samples, while commenting that it was becoming a manual dexterity test to open the feed ports, Grissom maneuvered *Molly Brown* and discussed the upcoming rendezvous with the Titan stage, which was expected at GET 2 hours, 8 minutes and 52 seconds, at an elevation of 18 degrees and a distance of 19 miles straight ahead of them. Grissom confirmed that their alignment was just about perfect.

He then yawed the spacecraft 180 degrees, so they were now travelling blunt end first, effectively 'flying backwards', which became clearly obvious to both pilots. Grissom then moved *Molly Brown* 16 degrees nose down to the retrofire attitude to see what it looked like going backwards. This was an attitude they would adopt prior to ending their mission and re-entering the atmosphere.

Young:	*"Oh man!... I'll tell you, I need some of these missions where I can look out of the window. I haven't looked out of this window a second and a half. It's beautiful."*
Grissom.	*"You know if I lined up the yaw, I'd line it up right there. What does it look like to you?"*
Young:	*"Look's to me like you got it Gus… that looks good to me."*
Grissom:	*"That's not what the 8-ball shows. Its right there, no doubt about it."*

Grissom then initiated a roll to rotate the spacecraft at approximately GET 2 hours.

Grissom: *"Let's try it upside down once."*
Young: *"Okay, lets watch everything float to the ceiling."*

Grissom smoothly turned the spacecraft, stating "*that's hard to fly. The sun is sure bright*." He then commented that if they were going to see the booster in eight minutes time they were facing the wrong way and would have to turn *Molly Brown* back around, with the small, nose end pointing in the direction of flight.

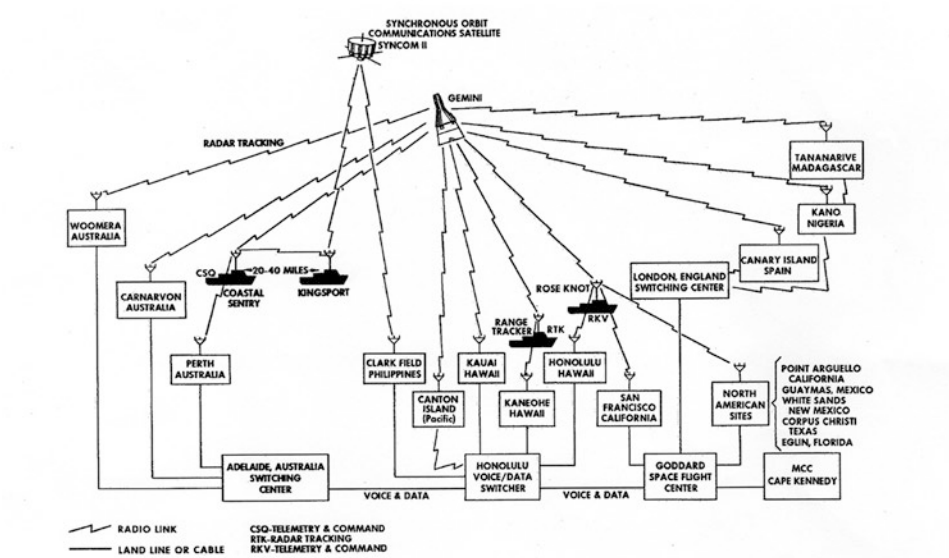
Traveling through the night pass, they swung the spacecraft around again, noting the sudden change as they concentrated on what they were doing.

Grissom: *"OK, let's start this thing right now. Okay it's pitching up slightly. Going up above zero. I don't have a scanner light. Man, it is dark!"*
Young: *"Hey, look at those thrusters glowing!"*

At 2 hours 8 minutes into the mission, the PAO spokesman at the Cape Mission Control reported that the aircraft which had gotten into trouble in the eastern Atlantic was now approaching Las Palmas in the Canaries, where it had been met by a second aircraft and was being escorted to the airfield. Meanwhile:

> PAO Haney: "The spacecraft at this time is passing over the southeast coast of Africa and they should at this time be seeing the booster. One of the prime reasons why they will be able to see it, unlike past Mercury flights, is due to the dramatic change in orbit. They will yaw around and observe it flying some twenty to twenty-five miles right over them and they will probably get the best view of it when it is out well before them."

But there was no word from the spacecraft transcripts on sighting the booster.



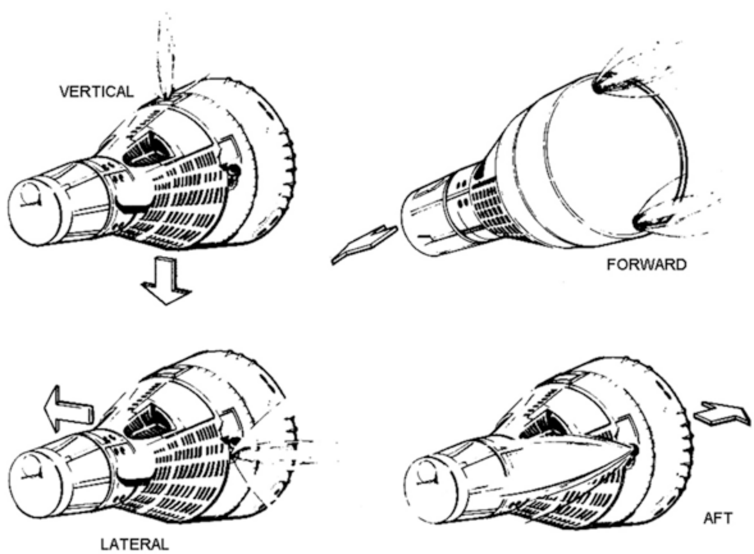
NASCOM Network Support for Gemini 3.

Moving out of plane

At GET 2 hours 10 minutes, the crew had to give an oral temperature reading to the ground, as well as taking photos of the translational thruster firing. At this point, Young mentioned that they had hardly used any film out of the 130 feet (39.62 m) available. Post-flight, Young reported "During the second orbit I photographed the forward-firing thruster during the translational checks. The plume of the forward-firing maneuver thruster is a large, yellow-orange glow with a lot of spark and extended 30 to 40 feet (9.14 to 12.19 m) about 30 degrees to 40 degrees subtended angle. It's a very spectacular view at night."

Young also reported that he had returned the waste valve back to NORMAL a few minutes later, after a further evaluation of the waste system, adding to Grissom: "*Your recommendation on that covering underwear is WELL TAKEN.*"

As Grissom prepared for the next scheduled maneuvers of *Molly Brown*, he commented on the difficulties with on the 8-ball once again: "*Man! I don't believe this 8-ball. It is way off. Look at it. It is way off.*"



Translational maneuvering capability of the Gemini spacecraft.

Over CSQ, stationed in the Indian Ocean, the astronauts began a series of translational systems check burns (out-of-plane) to turn the spacecraft +90 degrees (turning *Molly Brown* to the right), but without pitching or rolling it as they did so. To achieve this, Grissom first set the computer mode to CATCH UP, the platform mode to ORBIT RATE and the attitude control mode to DIRECT. He then initiated a thrust-aft for 16 seconds until the forward-aft IVI read 10 ft./sec (3.04 m/sec). He followed this with a small thrust forward of just 1 ft./sec (0.3048 m/sec), followed by thrusting aft, also for 1 ft./sec (0.3048 m/sec), then repeated the small forward/aft thrusting process. During this maneuver Grissom should have referred to the 8-ball for attitude reference, but elected instead to look out of the window for reference due to the problems they were experiencing with the 8-ball, which had not been isolated at that time. The series of checks was terminated when Grissom swung *Molly Brown* back to the Small End Forward (SEF) attitude, then returned the attitude control mode to HORIZON SCAN. The instrument displays recorded a propellant reading of 66 percent before the burn and 62.1 percent afterwards.

Over the Indian Ocean, communications had to rely on the Syncom II satellite, as there was a temporary loss of communications with the Australian station. The crew was performing a translational burn that would alter the flight path slightly and, if entirely successful, would see *Molly Brown* land some 30–40 miles (48.27 to 64.36 km) further north than if they had remained on the same ground track all through the three orbits.

At GET 2 hours 23 minutes, Pete Conrad, the Capcom in Carnarvon, Australia, came on the air-to-ground. Communications had been restored and the "GO" for the third orbit was given.

Conrad: "Molly Brown*,* Molly Brown*, Carnarvon Capcom. How do you read?"*
Grissom: *"Carnarvon, this is* Molly Brown*. Read you loud and clear."*
Conrad: *"Very good Gus. We'd like to get a blood pressure on the co-pilot please and could I have your status?"*
Grissom: "*Okay. Blood pressure's coming and our status is green.*"

Conrad did not have any communications with Mission Control at the Cape at that time, but asked the crew to run through the flight control problem with him. Grissom confirmed that the yaw drift was very slow, at about a quarter of a degree each second and that, at the time, he was in PULSE mode aligning the platform. Conrad suggested that it looked to him like a mechanical problem in the valve. Grissom concurred that it must be very slight, as they could not see the pressure go down and they had gone through everything suggested. Conrad then asked how Young was progressing with evaluating the waste system, to which he received the curt reply, "*in [the] process.*"

By the time they passed out of the range of Conrad in Carnarvon, Young had completed his evaluation of the waste system.

Young: *"Well that's great! I can't bust up the bag* [the bactericide bag]. *Sure like to get that smell out of here and the only way I can do it is bust the bag."*

Grissom misunderstood which bag Young wanted to break, so Young confirmed it was the bactericide bag and not the waste bag itself. Then the problem of stowing the waste bag arose, as Young tried to pass it over to Grissom.

Young: *"Can you stick this on your side?"*
Grissom: *"That mess? Doesn't that go in your food box?"*
Young: *"Would if there was any room in it."*
Grissom: [seemingly reluctantly] "*I don't have any room.*"
Young: *"I don't either."*
Grissom: *"Drop it back behind the seat, I guess."*
Young: "*I'll try to stick it in the food box.*"

Habitability of *Molly Brown*

One of the crew's tasks during the mission was an evaluation of the living conditions onboard *Molly Brown*, in light of the much longer missions planned. The overall design of the Gemini crew compartment could not be changed, but some of the internal arrangements and facilities could be re-examined based on the experiences of the first crew on this short mission. "We need a larger cockpit and a better way of storing things," noted Grissom after the flight. "The storage just isn't satisfactory." (see sidebar *Stowage on Gemini*).

The most significant habitability issue was due to the close proximity of the windows to the normal position of the astronauts' heads, at about 8 inches (20.32 cm) with the suit faceplates closed during orbital flight. This would cause a problem during their parachute descent later in the day.

Inside the crew compartment in their 'weightless' state, both astronauts found themselves about one or two inches (2.5 to 5 cm) above their seats. They found that their bodies naturally straightened out and their heads made contact with the inside of the hatches. For two astronauts who were slight in stature this was tolerable, but for the larger-framed astronauts this had implications for the longer flights coming up on Gemini 4, 5 and 7. Both men found that the Gemini G-3C space suit was operationally very good and that removing the inner cloth liners from the suits prior to flight helped in both mobility and comfort.

STOWAGE ON GEMINI

Each mission would have decreasing quantities of food and increased quantities of waste as the mission progressed, so provision for the storage of both would be a challenge in the tight confines of Gemini. In addition, locations had to be found to house cameras, film, camera accessories and the hardware and software for experiments. Then there were the various log books and data cards used to support and record data. In zero-g, these would all require restraint and stowage. Other factors to consider in this logistics puzzle were the duration of the mission, the size and nature of item to be stowed and the immediacy and frequency of use. For most of the loose items, Velcro hook material was applied to the spacecraft walls, hatches, seats and instrument panels, with Velcro pile attached to the items to be restrained. For such a short flight, there was little need to apply Velcro hook sheets everywhere on Gemini 3, but with each successive flight, the next crew always requested more Velcro patches to be added. That is until Spacecraft 8, when most of available locations had been used up.

Due to its short duration and the small amount of equipment needed, stowage was not a problem for Gemini 3. Therefore, Spacecraft 3 did not include all the fixed stowage containers that would be a feature of later spacecraft. On *Molly Brown*, the locations for the Right-Hand Aft Box and modified Whirlpool central food box became useful extra space for Grissom and Young, whereas on all subsequent spacecraft, except Spacecraft 6, this storage space would be fully utilized for mission supplies. Both the Left- and Right-Hand Torque Boxes were used to install various experiments in hard shell containers. The design of these had to ensure adequate clearance for the possible use of the ejection seat, not cause interference when the crew wore their pressure helmets and withstand hatch opening shock loads of up to 40 *g*. For Gemini 3, the Left-Hand Torque Box included the Sea Urchin kit, while the Blood Chromosome Unit was housed in the Right-Hand Torque Box.

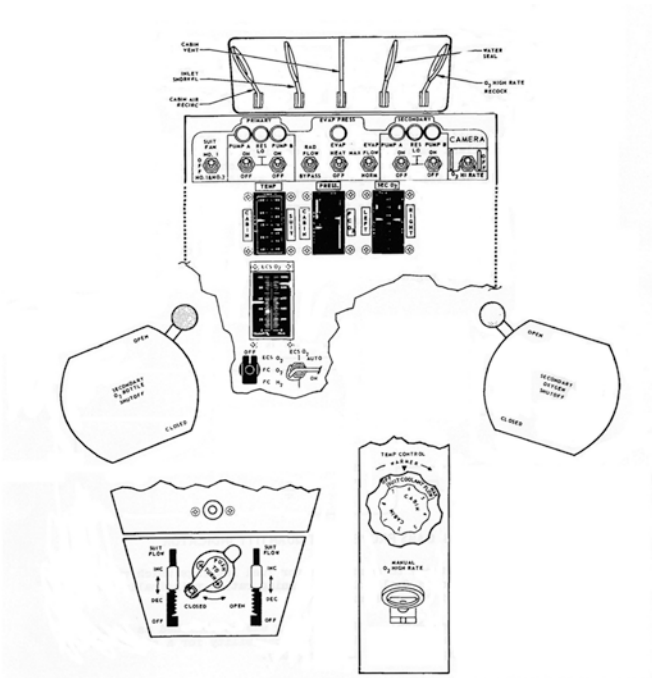
Gemini featured at least six hard-mounted items in each spacecraft, though what was stowed in those locations did change as the program evolved. The *inflight medical kit* was mounted between the right-hand seat and the sidewall on Spacecraft 3 through 7, but on the other side for Spacecraft 8 through 12. The *voice tape recorder* was mounted permanently between the right-hand seat and sidewall for Spacecraft 3 through 7, but from Spacecraft 8 its location changed due to individual EVA needs. There was a *'Swizzle' reach extension stick* stowed on the right-hand side of the overhead circuit breaker panel close to the switch guards, which could be used by either crewmember to activate any switch that was out of reach, or while the astronaut was restrained in his seat. The stowage location for the *optical sight* was under the left (Command Pilot) instrument panel. A *pouch* measuring 4 × 6 × 1.5 inches (10.1 × 15.2 × 3.81 cm) was located directly below both the left and right circuit breaker panels and was used during a mission for the stowage of small, lightweight items. Each spacecraft had *dry stowage bags*, attached to the footwell side walls with Velcro and used for stowing charts, sunshades, reflective shades and flight data books. On Spacecraft 3 through 9, there was also a *plot board pouch* installed on the inboard sidewall of the left footwell, which contained charts and flight data books in addition to the plot board.

One of the concerns from both astronauts was the insufficient lighting of the central instrument panel and they suggested that both it and the flight-plan roller, which was also difficult to read, should be back-lit. Young reported that regardless of whether cabin lights were turned up or not, looking back into the cockpit after viewing outside on a daytime pass meant that "you can't see a thing." Grissom added that the light could be dimmed correctly during the night pass, but while they could see both the flight instruments and outside the window, they were still unable to see the center console clearly. "We need more intensity during the day and the capability to control it down at night. We can't control it properly at night," he advised. "If the flight plan roller was back-lit, that would relieve a lot of the problem, because that was one of the things most difficult for us to see. I used the finger-tip lights [on his spacesuit gloves] a lot more than I ever thought I would," he admitted.

Young commented: "On a long mission, the crew is really going to have trouble with storage. For example, I didn't have any place to put the urine collection device. I couldn't think of any place to put it and it had filled up with air and was twice as big as before. I had to cut it to get the air out." Grissom thought it had been expanded by gases formed in it but Young stated he had not urinated in that particular bag. The fact that it had been stored at 15 psia internal pressure in a cabin at only 5 psi was probably the reason why it had overinflated.

Back onboard, it was now time to complete a horizon scanner check, but they noted that the O_2 was not at HIGH RATE.

Grissom: *“I’m sure uncomfortable.”*
Young: *“Yes it’s bad.”*



Gemini’s Environmental Control System controls and displays.

Grissom suggested leaving the heater switch off and letting the oxygen pressure fall a little. Young noted at the start of the O_2 High Rate, at GET 2 hours 41 minutes into the flight, that the oxygen quantity was reading 25 percent and the cabin pressure was 5.1 and building slowly. He pointed out that the suit inlet temperature was going up. For the next few minutes, they monitored the oxygen High Rate and the horizon scanner. Viewing out of the window was difficult due to the brightness of the sun. They spent seven minutes at the O_2 High Rate.

During the post-flight debriefing, Young expanded on the ECS issues. “The ECS condensation problem was taken care of by turning off the cabin fan and turning the cabin cooling system to FULL HOT. The cabin temperature got up to 92 degrees and I don’t think we ever had enough water at the end of three orbits to condense out. Most of the water in the cabin was introduced by me in missing the uriceptical on the first try, and that introduced a ball of water a couple of inches in diameter. Most of it I managed to sop up, but at those cabin temperatures you would get water eventually.” Neither astronaut actually noticed any additional water and agreed that the problem of additional water in the spacecraft caused by the ECS failing to cope with it needed to be addressed before the longer flights. Young added that he was not doing that much physical exercise, so there was not a big problem, but he thought the cabin should have been a lot cooler than it actually was. He found that the largest heat load was when he tried to break the bactericide bag into the defecation bag “I really put a heat load in the suit that time. It wouldn’t break, and I was really frustrated,” Young admitted post-flight.

At GET 2 hours 49 minutes 48 seconds, Neil Armstrong, the Capcom at Hawaii, called up to *Molly Brown*. Grissom told him that he had too much movement of the 8-ball and was struggling to keep it aligned (caged) as it was drifting ten degrees off from where it should have been. When Armstrong asked if Young’s 8-ball was working correctly the pilot replied that it was not. “The ORBIT RATE isn’t any good,” he reported

They then communicated the various reading and updates to Armstrong, with Young reading down the stats from the onboard instruments.

Young: *“Cabin temperature – 92. Suit temperature – 58. Cabin Pressure is 5.6. Suit CO_2 is ¾ millimeter. Left bottle is 5100. Right bottle is 5050. O_2 quantity is 62. Pressure is 840. Source temperature is 55. Source pressure is 2000. OAMS fuel temperature – 68. RCS A temperature...Gee! A temperature is 87, A pressure is 2000 – B is 2650…”*

This type of commentary was standard in spaceflight, especially in early test flights of a new spacecraft, but it did not make good copy for the media. It also made reading the progress of the mission difficult, leading to some awkward questions from the press for the astronauts when they got home. But the controllers were happy and if they were confident then the crew remained relaxed to do their job, letting others report on their progress.

Armstrong: “Molly Brown*, Hawaii Capcom. Everything looks good on the ground. We will see you on the next time around. Aloha.”*

Armstrong also reaffirmed the “GO” for the third orbit. As the three-hour mark of the flight approached, Gemini 3 passed into the range of the *Rose Knot Viktor,* whose Capcom asked for Grissom’s respiratory ‘maneuver’ [see below] and the pilot’s oral temperature and blood pressure.

Doctor, Doctor…

Throughout the flight, physicians on the ground at MCC and at each tracking station constantly monitored the physiological measurements recorded by the bioinstrumentation system, together with environmental parameters. The data from the remote sites was transmitted via voice-data lines to MCC to allow the flight surgeon to observe real-time data while *Molly Brown* was out of direct contact with MCC, while the electrocardiograms and pneumograms for each astronaut were recorded on the onboard biomedical tape recorder. Following the mission and a review of the data recorded, no unexpected pattern was found on the electrocardiogram recordings. As expected, there were increases in rates associated with dynamic portions of the flight, such as launch and re-entry and during the evaluation of the food and waste systems. The respiratory ‘maneuver’ mentioned previously required the breathing rates measured by the impedance pneumograph to be within the expected normal range. To record their respiratory rate, Grissom and Young had to take three consecutive deep breaths, which provided a satisfactory measure for correlating time on the spacecraft's biomedical tape recorder. Throughout the flight, the astronauts measured their temperature orally at specific intervals, as defined in the flight plan, but it was the blood pressure equipment that the astronauts found the most troublesome.

The aim was for each astronaut to take three measurements of blood pressure, as scheduled on the flight plan. Young was able to do this and from these, increased systolic and diastolic pressures were observed early in the flight, which gradually decreased as the flight progressed. The official post-flight report indicated that there were too few measurements to draw any significant conclusions from this. The fact that Young went on to make another five spaceflights over the next eighteen years suggests that these readings may have been connected to the fact that this was his very first spaceflight in a new spacecraft, with all the increased excitement, tension, stress, relief, adrenalin and other natural conditions that such an activity after a long period of preparation would bring on. On the other hand, Grissom did not record any blood pressure readings in the time allotted, as he was unable to mate the blood pressure blub correctly to the fitting on his pressure suit. Post-flight examination of the system could not find a mechanical failure, but both astronauts complained that the design of the equipment had changed since they had trained for it.

At this point in the flight, the Capcom down on RKV suggested to Grissom that if he was drifting in ORBIT RATE, he should select a mode of his own for the tracking tasks coming up as they crossed the coast of the United States. PAO Paul Haney noted the lack of conversation going on at the time.

> PAO Haney: "Characteristically, very little conversation going back and forth, strictly pilot talk, evaluating systems. Even Gordon Cooper, who was not noted as a loquacious pilot during his 22-orbit flight, has been moved to communicate on the lack of comment by Gus Grissom and John Young during this flight. During the check of the control system over the Pacific Ocean, Grissom noted some drift in his 8-ball – or flight direction needle on his side of the spacecraft – he seems not unduly concerned about it – apparently it is a slight drift and he is looking into it and I am sure we will have it solved in very little time. This is Gemini Control."

As they approached the coast, Young read back the quantity reading he had logged a few minutes before. Halfway through, Grissom pointed out that he was supposed to be taking pictures of the ground. An under-pressure Young responded, "*I know it, I know it"* and continued to complete his readings.

As they passed out of range of RKV, heading to Guaymas, Grissom reported that he could not see any good ground targets at all.

> Young: *"Man, just pitch over and I'll take a picture; can you pitch it down and towards the States, Gus?"*

Young gestured with his hands on the Orbital Path Display that Grissom should try to come in sideways with the nose pitched down 90 degrees, because he could identify some targets to the north of them. Grissom could not see anything at all. Meanwhile, Guaymas was asking for a report on the Coolant Pump Checks, which the crew ignored as they were too busy trying to secure a target on the ground. Young noted a target, but Grissom still could not identify it, so Young asked him to point the nose straight down, offering both windows for viewing.

Grissom: *"I can't see over there, John. I'll roll back to the right so we can both see. Ah yeah, there is one right down below here. Let's see if I can get it… I'm tracking him right on around."*

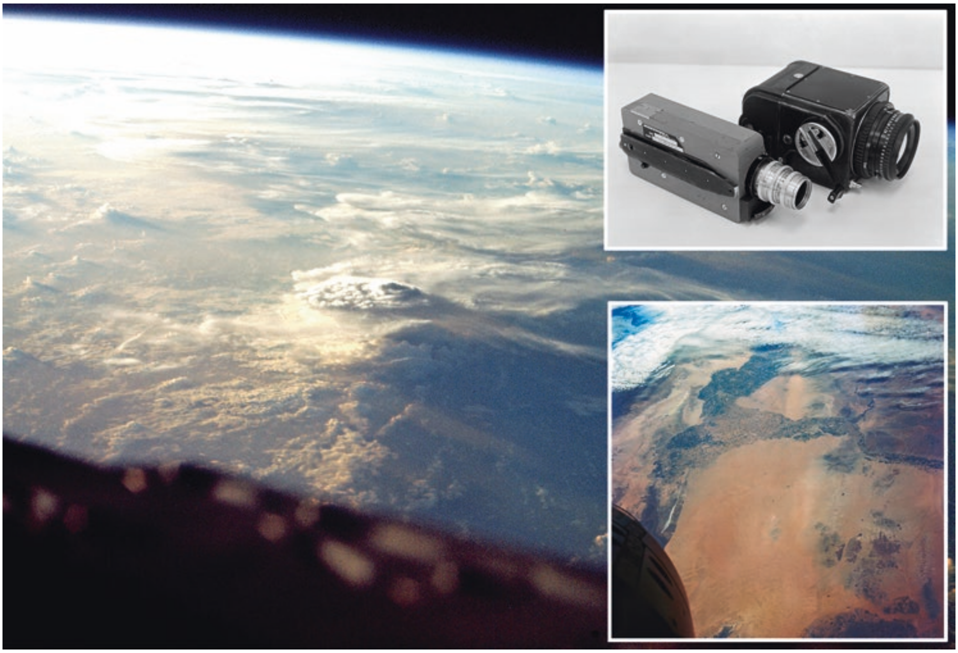
At the same time, Grissom confirmed that Young had completed the Coolant Pump Checks.

Capcom: *"Roger what is the status on the checks?"*
Young: [A little frustrated at being asked while try to help Grissom] *"What difference does it make? We could get the B pumps to come on simultaneously."*

During the post-flight debriefing, Young commented that Guaymas had reminded him to complete the coolant pump check on the second orbit and expanded on his reluctance to do so at that time. "I think they [Guaymas] were a little too interested in finding out how it came out. I don't think it was all that important at the moment." The B-loop secondary system had been off, so he turned on the B-pump but waited to get the cold sludge out of the line, knowing that the A-pump would not come back on line if the content of the B-pump was even a little viscous. "So I wanted to wait. But they [Guaymas] wouldn't have it." He then explained that he turned on the A-pump but then the B-pump stalled, which he expected with the system on the secondary loop, so he then went to the primary loop and turned the A-pump on there, but it too would not come on. Not wishing to troubleshoot the system at this point, he cycled the primary A-pump off and then on again without switching off the other system to double check. As Young explained, "The only requirement for ever having both pumps on at the same time in one loop would be if you lost one loop in the wrong fuel cell and you are having marginal flow." In theory, it should have been possible to get both pumps on line during that kind of problem if the decision was to remain in orbit, but there was no requirement on this mission to put that to the test. That would be done during further ground evaluations.

The astronauts also responded post-flight to questions about the planned communication sessions during ground station passes. Generally, they did not think there was a problem, but did suggest standardizing the procedures so they all used the same terminology. The astronauts also suggested that the ground communicators should keep to the basics such as "retrofire" and note the time without reference to GMT, as the crew already worked from that reference. The ground communicators at some stations also called up parameters in different order than the astronauts were used to, which meant that Young had to search all over the check card he had prepared pre-flight. They also suggested dropping irrelevant actions, such as asking for a radio check after talking to the crew on the radio for several minutes, or asking the crew to complete a procedure they already had in motion. Grissom clarified their concerns: "I think it is alright for them to call and check sometimes and say 'is [the task or experiment] completed?', or 'have you started?' I don't object to that, [but] I do object to them asking for all the details of what went on. They don't need to know it, unless it is something that affects or has a bearing on a serious problem."

Back on the mission, they were now coming up on the Gulf of California for the second time, but Grissom still could not see the Salton Sea. As they headed for El Paso, Grissom pitched over, asking where it was.



[Main image] A view of clouds, as seen from Gemini 3 over the southern end of the Malagasy Republic (now Madagascar). [Inset top] The cameras carried on Gemini 3. The lighter colored one is a McDonnell 16-mm sequential camera, with a 120ft. film capacity and a 25mm f/1.9 lens. The black camera is a modified Hasselblad hand-held with a 70-mm film back, using an 80-mm f/2.8 lens. [Inset bottom] As *Molly Brown* passed over Northern Mexico on its second orbit at an altitude of 90 miles, John Young took this image with the 70-mm camera loaded with color film, with a lens setting of 250th of a second at f/11. The Sonoran Desert is the large, light-brown area in the lower central frame, with the Colorado River running from the upper right to the lower left. In the lower portion of the picture is Mexico, with California at the upper left and Arizona upper right.

Young: *“That’s the mountain range right there. See that hill right over there? I think El Paso is under the clouds.”*

Photo identification later showed this town to be Mexicali, with some street divisions evident in the photos. After the flight, Grissom commented on the difficulty of looking at the targeting ‘pipper’ against the Earth: “You can’t see the pipper on the target on the bright Earth, so it’s difficult to tell. The pipper was really faint,” he reported. This was an early indication of the difficulty of maintaining clarity against the backdrop of an illuminated Earth, which would come back to confuse the later crews during docking missions and lead to refinements regarding the way spacecraft are maneuvered during rendezvous in Earth orbit. In the Shuttle assembly and supply missions to Mir and ISS (1995-2011), for example, the Orbiter approached from 'below' the station, with the Earth behind the Shuttle windows to avoid confusing the crew on final approach. [4] Grissom was also not happy with the reticle, commenting that "it sticks up in your way and interferes with your outside vision, and you can't see it. It isn't good for what you want."

At this point in the mission, the ground again requested the status of the propellant with the pump check. There was no problem, but they just could not do it simultaneously. As the Texas site came into view, they reported on the status of all platform modes. They also had an update on the weather at the recovery site, with broken clouds, visibility of 20 miles (32 km), wind at 20 knots (23 mph or 37 kph) and 5-foot (1.5 m) seas. Via the Texas site, Cooper at the Cape Mission Control asked the crew if they had been able to view the spent booster from their Titan.

Grissom: *"We were facing the wrong way at the time. Making a Horizon Scanner check."*
Cooper: "*Yeah, I was afraid you would be. That was a little bit tight in there.*"

Grissom agreed. The second stage of the Titan continued in orbit for another day, re-entering the atmosphere on March 24. [5]

Cooper: "*Did you manage to see anything over the U.S. because of the clouds?"*
Grissom: *"We could see the southern part of California and Arizona, I guess. That was about it."*
Cooper: "*How's the weather, in general, around the world?"*
Grissom: *"Very cloudy… we've seen very little land… not even much water."*

After the mission, Grissom stated that the tracking task across the States was "a pretty wild operation." With the reticle in place, Grissom had followed Young's instruction to turn *Molly Brown* sideways, "but it turned out he could see a target, but I couldn't. I couldn't see his target, so we turned it [*Molly Brown*] back around, and we picked up a target just about underneath [us] and tracked it for quite a while." Grissom was not sure how closely they tracked the target, as he had to revert to DIRECT mode to follow the target more closely. Grissom commented: "If you pick up your target early, then it wouldn't be any problem to get set up," suggesting that a switch added to the DIRECT or RATE command might be a better option for the future. NASA was not the only one looking at this type of ground optical tracking. The USAF was also evolving their classified surveillance techniques for the Manned Orbiting Laboratory program at that time.

> PAO Haney: "This is Gemini Control. You have been hearing, for approximately the last ten minutes, a live transmission from the Gemini 3 spacecraft. During the course of that conversation … the subject came up of a slow leak which had caused plenty of questions out at the press site [at the Cape]. The answer to the question is … that the spacecraft does seem to have a very slight leak in the yaw thruster. The Mission Director [Kraft] advises that it is of the order of approximately a quarter of a degree per second. It is not considered a problem. Otherwise the spacecraft seems to be performing nicely. During the Cape pass, a digital command was sent up, resetting clocks, updating

computers – everything performing nicely. Three hours and 16 minutes into the mission. This is Gemini Control."

The astronauts' wives visit Mission Control

Shortly after *Molly Brown* entered orbit, the phone rang again in the Grissom home. It was an official from NASA asking whether, as his wife, Betty would like to go to the new Mission Control Center at the nearby MSC. This facility in Building 30 was not yet operational, but was monitoring the flight pending full mission operations starting with Gemini 4. To have the opportunity to talk to her husband, while he was in orbit, was an unprecedented offer, but when she asked if her sons could attend as well, she was told that was against NASA policy, which upset her and so she refused. A decade later, Betty Grissom recalled the event in *Starfall.* "My kids are old enough not to disturb anyone," she wrote. "If my children can't go then I'm [not] good [enough] to go [either]." Minutes later, the phone rang again and she was now informed that an exception had been made and she could indeed bring her sons with her during the second orbit of the mission. During the visit, Betty recalled that "We didn't talk to Gus. He didn't want to talk to me and I didn't want to talk to him as he was too busy with only three orbits." [6]

During the second orbit, Barbara Young also traveled the short distance from their home to the Manned Space Craft Center to visit Mission Control, but with her two children being looked after back at home, she stayed only a few minutes. She later admitted that she found it all a little confusing: "You put on the earphones and the voices sound as if they're coming from under water." [7]

On subsequent missions, the wives of the crew were able to talk to their husbands in orbit by radio, while their older children were allowed to visit the viewing rooms at MSC. Five decades later, astronauts on the ISS use social media and direct cellphone calls to keep in touch with their families at home, as well as a wider global audience, during their long missions on the station.

Taking *Molly Brown's* 'pulse'

Grissom reported after the mission that the PULSE mode was excellent for controlling the spacecraft and for making fine attitude or rate adjustments. He mentioned the difficulty that he had in tracking down a town just north of the Gulf of California using the PULSE mode, but there were a number of mitigating circumstances that increased the difficulty of the tracking task. He noted that by far the largest problem was the absence of good tracking targets due to the cloud coverage. "We finally located a small area that was clear," Grissom wrote, "and we had to hurry to get the bore-sight reticle on the target. By this time the target was almost below me and thus the rates were changing rapidly. I tried to track the target using the PULSE mode, but it was moving too fast so I switched to DIRECT." Using this control mode, Grissom was able to hold to within one-half a degree of the selected target point. His biggest difficulty at the time was the issue of seeing the "pipper" on the target. They were moving very fast and their time was limited. This became very evident to them and in summary, Grissom suggested that the PULSE mode might work satisfactorily if the target could be acquired early and the reticle was brighter. Given the likelihood of the weather not being cooperative to permit early acquisition, he suggested that the use of the DIRECT control mode would be required on future flights. [1]

At 3 hours 16 minutes into the flight there was a bad tape change. Because of where the recorder was located, Young had difficulty both in seeing whether the recorder latching mechanism was secure and in trying to verify that it was closed properly by feel because of his gloved hand. On the third reload, he had not closed the recorder door properly, which resulted in the loss of recording on one tape cartridge. The recorders failed to function until GET 4 hours 8 minutes. However, conversations were recorded via UHF on the ground from the time the flight acquired *Coastal Century Quebec* on the third and final orbit, at GET 3 hours 48 minutes 14 seconds.

Throughout these first two orbits, *Molly Brown* had continually drifted to the left in yaw while in the HORIZON SCAN or PULSE mode of operation. Grissom would constantly bring it back to zero yaw, but it would drift again to the left, building up to as much as three degrees each second. The crew assumed it was a leaking thruster and went through a number of procedures to try to stop it, all with negative results. However, as the flight progressed the yaw-left drift seemed to decline steadily, to the point that by the third and final orbit, the drift was barely noticeable.

References

1. *Command Pilot's Report* in Astronaut Flight Reports, March 31, dated 1966 (but probably 1965?), M-913-65-03.
2. **Gemini!** Virgil 'Gus' Grissom, Macmillan, 1968; also, *GT-3 Flight Crew Self-Debrief*, March 23, 1965, p. 2-4.
3. **Forever Young, A Life of Adventure in Air and Space**, John W. Young with James R. Hansen, University Press of Florida, 2012, p. 85.
4. **Linking the Space Shuttle and Space Stations (2017**) and **Assembling and Supplying the ISS (2017)**, David J. Shayler, Springer-Praxis.
5. **The R.A.E. Table of Earth Satellites, 1957-1989**, compiled by Desmond G. King-Hele, Doreen M.C. Walker, Alan N. Winterbottom, J. Alan Pilkington, Harry Hiller, and Geoffrey E. Perry at the Royal Aircraft Establishment, Farnborough, England, 4th edition, 1990, p. 73
6. **Starfall**, Betty Grissom and Henry Still, Crowell, 1974, pp. 150-151
7. *"He's on his way…and it couldn't be prettier*, Miguel Acoca, in *Gemini's Journey*, Life Magazine, April 2, 1965, pp. 34-42

8

Got your seat belts hooked?

"That old ticker is really ticking away now, I'll tell you."
Gus Grissom, just prior to retrofire on Gemini 3

There had been an inadvertent gap in communications at the start of the third orbit, between Gemini 3 passing over the Cape and picking up the *Coastal Sentry Quebec* (CSQ) in the middle of the Indian Ocean. At that point, the U.S. Navy updated the crew on the weather at the primary landing area and confirmed, thanks to a remarkably clear picture from a Tiros satellite, that there was a nice, sunny, open stretch of water awaiting *Molly Brown* at the end of this orbit.

For much of the third orbit, John Young took control of the spacecraft, affording him some experience for a possible later command seat. Updates of the proceed times for retrofire were sent to CSQ via the Syncom communications satellite. The burn would be Blunt End Forward (BEF) with an angle rate of 000, which meant that the centerline was exactly horizontal to the Earth, with no motion to the left or to the right and imparting a burn of 96 ft. /sec (29.26 m/sec). The duration was to be 1 minute 49 seconds and the burn would lower the perigee of the orbit to about 50 miles (80.45 km). This maneuver, called the pre-retro burn, was to be performed slightly to the east of the Hawaiian Islands and following it, *Molly Brown* would remain in the BEF attitude until retrofire.

As this information was being sent up to the spacecraft from CSQ, Public Affairs Officer (PAO) Paul Haney in Mission Control at the Cape reported that the C-54 aircraft that had been in trouble earlier in the flight had landed safely at Las Palmas in the Canary Islands.

Capcom: "Molly Brown*, CSQ Capcom… What's the Status?"*
Grissom: *"We are 'GO'."*
Capcom: *"Roger, you look good from the ground."*

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_8

Onboard the spacecraft, the two astronauts had completed the retrofire checklist and were ready to initiate the sea urchin experiment again at GET 3 hours 51 minutes 14 seconds. Five minutes later, Pete Conrad, the Capcom at Carnarvon in Australia, came on air and asked for an update on the OAMS. Grissom reported that OAMS propellant quantity was 55 percent, helium source pressure was 1950 and source temperature read 81 degrees.

During their conversation, Conrad asked Grissom and Young if they were looking at the ground (Australia) as there was a big fire set up in their honor at Carnarvon. Unfortunately, they were travelling blunt end first, so the windows were not in the right place to view the display on the ground. A minute later, Conrad relayed a message from the medics to Young regarding the food evaluation. Grissom told him they had no time to deal with that and that they would see them when they got back, Young added that everything was in order.

When asked post-flight about the communications procedures that were used by the ground to transmit computer parameters to the spacecraft, Young thought they were adequate and was appreciative of the work of Conrad at Carnarvon, unaware of the challenging issues at the site a few days earlier. "He did a beautiful job…just the way we discussed doing it," Young commented. "We got all the information down, and we verified all parameters in the computer before we left the station. Can't ask for anything better than that."

For most of this final pass, the conversation concerned preparing for the retrofire and the status of onboard systems, but the rookie Conrad did ask Grissom one question before going out of range: "*How's the flying up there?*" Grissom replied, "*Great!*" Part of the conversation going back and forth between the spacecraft and Conrad at the Australian site concerned reading out fuel quantities. One report from Young indicated that there was still about 55 percent of the fuel on board, which showed very good management of that particular system and, as PAO Paul Haney noted back in Mission Control at the Cape, earned some approving nods from the systems people there. At GET 4 hours 8 minutes 27 seconds, there were just 25 minutes to retrofire… and the scanners were still playing up.

Grissom: *"Seems like one of those scanners just needs to rest every now and again, you know?... Scanner went out at 18:33* [GMT]… [39 seconds later] ... *there's that scanner light again…* [1 second] *it's out…* [4 seconds] *it's on again, it's out again* [10 seconds] *scanner lights out again…* [3 seconds] *it's on again…* [28 seconds] *scanner light is [still on]."*

Grissom then questioned what Young had seen of the RCS thrusters reflecting the sunlight when the sun shone on the nose of *Molly Brown*. He then asked the pilot if his seat belt was hooked up for the re-entry. On his first flight into space, Young wanted it to keep going.

Young: *"Can you take it around a couple more times?"*

Grissom: *"I don't know. Got your shoulder harness?"*

Young: *"Yes, finally… now let me go through this checklist in an orderly manner… Okay. All equipment is stowed."*

Grissom: *"There comes the sun… Man! With that sun shining on the nose, I can't see anything now."*

Grissom stated after the mission that "The longer we flew, the more jubilant we felt. We had a real fine spacecraft, one we could be proud of in every respect." [1]

Vice President Hubert Humphrey (right) congratulates controllers during his visit to Gemini MCC at Cape Kennedy during the Gemini 3 mission.

Every minute of the mission had been timed to perfection. Onboard the spacecraft, the crew had a clock set to GMT and an Event Timer to count up to 99 minutes from launch, which was reset as required. Grissom let the event timer run from launch until the first burn was made at GET 1:33. By the time he had completed the burn and squared away, the GET was 1 hour 40 minutes, so he set the timer 40 minutes in advance of elapsed time on his wristwatch, keeping it that way until they were over the Carnarvon station on the third orbit, 34 minutes prior to entry.

During the post-flight debriefing, both astronauts commented on these important devices, which enabled them to keep track of current operations and upcoming events. Grissom said that the event timer had worked perfectly throughout the mission, but when he asked Young about the GMT clock the pilot just laughed. Grissom commented, “You mean the clock was probably running, but you couldn’t use it?” Young replied, “I used the GMT clock for elapsed time. [I] Punched it 3 seconds after engine ignition [at the start of the mission] and then wanted to punch it again after retrofire, but I just couldn’t quite get there from where I was. Stuck back in the cockpit, I could just barely read GMT on it… I would surely like to have an event timer on my side [of the cockpit] too.” Young reasoned that for a long duration mission, where there would be less activity to keep track of than on a rendezvous mission, an event timer would probably not be necessary, but Grissom added the thought, “That [the GMT] clock is bad. We should have two event timers in there that count up to more than 99 minutes.

Young explained that he wore two watches. “I used the *Acutron* for Greenwich Mean Time and an *Omega*.” Young explained that over each ground station they received a time hack.[1] Young wanted the ground to give them the time on the minute mark, but the ground set up the hacks on odd times. “We can’t set our stop-start features on odd times,” Young explained, “If they would give them to us on the minute, we would have been within milliseconds of having the proper GMT.”

Grissom acknowledged that there were plenty of timing pieces onboard and both of his watches worked well. Young suggested that for Gemini 4, the watches should be calibrated and adjusted. Grissom then explained that they were calibrated but not adjusted. One of the watches was running 15 seconds slow and he had been told that it took *9 days* [author’s italics] to adjust it. Since they got the watches quite close to launch, there was not enough time to correct the error. Young added that the GMT clock was also not available to them during training. “They wouldn’t allow us to look at that on the sim flight or during the rest of the tests, because they were calibrating its accuracy.”

After the mission, Grissom reflected on the planning of the inflight activities, admitting “I thought we had plenty of time in the flight plan, but actually we were a little rushed all the time. When we ran into a problem, we had to decide what to cut out. If you are on a 4-day flight you will probably have plenty of time, but in three orbits we didn’t have much time to look around… I didn’t really realize beforehand that certain things would be done at night. I had been kidding John about taking a picture of him having a bowel movement [but] it’s surprising when some things happen at night that you expect to happen in day light.” Grissom found it handy to keep track of the flight plan, “especially if you have a flight plan that is keyed to elapsed time like ours.” On longer missions, however, he was not so sure that such a system would be as effective.

At this point in the third orbit, the two men were now focused upon the timing of the retrofire, which was fast approaching. Grissom had also been keeping his eye on the 8-ball all through the final orbit, comparing it with the actual horizon to ensure that they were in good alignment when the time came for retrofire. He was still unaware of the earlier procedural error in using the device. He reported that the pre-retrofire procedures had been completed according to the checklist and on schedule and that all loose items had been stowed, exactly as performed in the simulator: “We double checked most of the procedures and switch positions to be absolutely positive that they were right,” he said later. After the flight Young suggested that the stowage of equipment should be taken out of the pre-retro checklist, with everything stowed prior to working that list. At GET 4 hours 15 minutes exactly:

Young: *“Okay, ready for this burn.”*
Grissom: *“Okay six minutes… I’ve got to start that computer… Man! There’s the horizon and it is beautiful.”*

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[1] A time hack is military term which means to take note of the current time, with the ability to set the watch to a specific time, stopping it, then restarting it the instant the time matches the displayed time on a reference time piece, in this case the update from the ground station.

Over the next couple of minutes, there was a fast exchange of comments between the two men as they prepared themselves and their spacecraft for the important burn. At GET 4 hours 20 minutes 14 seconds, Neil Armstrong, the Capcom at Hawaii, came back on line.

Armstrong: *"Hello* Molly Brown. *Hawaii Capcom."*
Grissom: *"Hawaii.* Molly Brown *is all ready for burn."*

There was very little conversation during the final Hawaii pass.

> PAO Haney: "In the retrofire maneuver [the pilots] will pitch down 16 degrees, their blunt end will be forward; that is, they will be flying with the blunt end [and their backs] leading the flight. The retros, with a thrust of 2,500 lbs. (11,100 N) each, will fire 1-2-3-4 fashion. They fire for five-and-a-half seconds each. This will decrease the velocity sufficiently to bring them in at the prescribed landing point. Downrange reports that the helicopters have started their engines. They will launch approximately one minute after the hour. This is Gemini Control."

Young received the OAMS retro burn information and inserted it into the onboard computer 12 minutes prior to the retrofire. Then, at GET 4 hours 21 minutes 12 seconds:

Grissom: *"10 seconds... we have 50 percent propellant quantity indicated… getting ready to fire… MARK."* [GET 04:21:23]
Armstrong: *"We got you. Start of burn."* [GET 04:21:28]
Grissom: *"Yes, its burning… there's 90* [seconds remaining] *… there's 80 … 70… you know, you can hear those big thrusters… 60… 50…"*
Young: *"There's a minute of burn."*
Grissom: *"40… there's 28… 20 … 10 …"*
Young: *"4… 3… 2… 1."*
Grissom: *"MARK! End of burn."* [GET 04:23:14]
Armstrong: *"Right. Mark. End of burn. Good show."*
Grissom: *"Let's see, did we get all of this?* [switch settings] *Now we're lined up good."*
Young: *"Okay and the retro-load is initialized now"* [on the computer]
Grissom: *"Now, don't go out of the Re-entry mode."*
Young: *"Okay, but I don't think it would make any difference as long as we go back."*

This last thrust maneuver was by far the largest Gemini 3 made and resulted in a reduction in velocity of about 70 mph (112.65 kph). It was this burn which placed *Molly Brown* on a gradual but inevitable re-entry trajectory, allowing the upper fringes of the atmosphere to drag on the spacecraft and gently bring it in towards the Earth. The velocity reduction was about 2 mph (3.22 kph) greater than desired, leaving *Molly Brown* a little high and leading to a stretched glide. When the next retro burn was 2–3 mph (3.22–4.83 kph) slower than planned, this further extended the glide and would result in landing that was about 60 miles (96.56 km) short of the planned point.

Now the two astronauts proceeded through the sequence of preparing *Molly Brown* for the firing of the retro rockets which would bring them home at the end of this orbit. Young rapidly ran through the process, with Grissom cautiously double-checking each step.

Young: *"Retro power – ARM."*
Grissom: *"Not now. At T_R-5, you mean?"*
Young: *"Well, this is the 5-minute checklist."*
Grissom: *"Okay, well, we'll just – 7:20 now… I haven't heard any of those squib isolation pyros fire yet. Have you?"*
Young: *"Yes, I heard the ones on the pad fire."*
Grissom: *"Did you? I don't remember, I guess."*
Young: *"I was listening for all that jazz."*
Grissom: *"Oh, were you?"*
Young: *"Oh, yeah! You have to listen for it to hear it."*

Grissom's natural concern as a Commander also reflected the awareness that everything had to work correctly and on time to ensure they were coming home. Unlike his ballistic flight on *Liberty Bell 7*, this time Grissom had to separate the Adapter Module and fire the retro rockets situated behind him to punch Gemini 3 out of orbit and begin the long fiery descent towards the ocean. Momentarily distracted by the thunderstorm display below him, Grissom observed that it would make for a really tough ride if they had to descend into it, as well as noting that from where he was viewing, it did not seem that they were as high as they actually were. Young spoke aloud, bringing his attention back into the cockpit: "*Batteries on. Mains on…*" Grissom cut in and asked if they now had everything they needed, "*Yes sir,*" came the quick reply from Young.

By GET 04:28:33, the *Rose Knot Victor* had established communications with *Molly Brown* to check that all was going well in the astronauts' preparations for retrofire and that procedures were mostly completed. Grissom confirmed that they did not need a MARK to start the process to separate the Adapter Module

Capcom: "Molly Brown*, RKV. You look good from the ground."*
Grissom: *"Roger. Thank you."*
Grissom: *"That old ticker is really ticking away now, I'll tell you."* [GET 04:31:56]
Young: *"Separate OAMS?"* [GET 04:32:34]
Grissom: *"Yes, go-ahead."*
Young: *"Separate electronics, separate adapter."*
Capcom: "Molly Brown*, RKV."*
Grissom: *"Hey, the adapter has separated."*
Capcom: *"Roger, we confirm on the ground, adapter sep."*
Grissom: *"Yes, you can really feel it … kickoff."*

In his post-flight report, Young stated that the OAMS lines had separated with a rather loud click. The electronics separated with a softer click as the little guillotines fired, severing the connections. However, the Adapter Module separation was "a loud bang," and he felt a little retrograde motion. "It felt as if it really kicked off. After the Adapter separation, an object flew out laterally from the spacecraft. I could see the object through the command pilot's window. It looked like the pump package, but it could have been the thermal curtain rolled up or some other similar silver adapter package." [2] "All of that junk flying around concerned me a little bit," confessed Grissom after the flight.

Grissom called the SEP OAMS event a medium-loud report; quiet but audible. The SEP ADAPT, however, was "very loud and is felt as a jolt," adding, "there was no doubt when the Adapter separation pyros fired; the firing caused a slight attitude disturbance."

Young: *"Arm auto-retro."* [GET 04:32:52]

Grissom was cautious about arming the retrorockets. He armed the first squib and waited three or four seconds to make sure it did not fire prematurely before arming the other three.

Grissom: *"Auto retro armed. Squibs armed… 16 seconds… 15 seconds…"*
RKV: *"10… 9… 8… 7… 6… 5… 4… 3… 2… 1… Retrofire."* [GET 04:33:13]

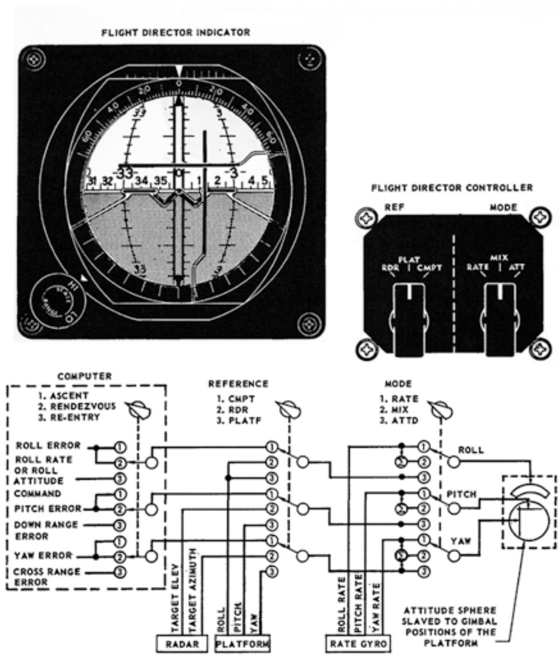
The countdown matched perfectly with the events timer and the computer on Gemini 3, with the first retro-rocket firing right on the zero-count. In fact, unlike the description Haney had announced over the PAO commentary, the firing was in cross-fire order, which was number 1, followed by 3, then 2, then finally number 4. This gave Grissom a momentary concern, as he briefly wondered what had happened to number 2.

Grissom: *"Auto-retro."*
Capcom: *"Manual retro… Rocket 3… Rocket 2…"*
Grissom: *"Three of them?"*
Capcom: *"Rocket 4…* Molly Brown*, do you confirm all rockets firing normally?"*
Grissom: *"All rockets fired normally and attitudes were right in the center."*

Evaluating his experience as the first astronaut to initiate a retrofire on Gemini, Grissom was asked after the mission if he thought the out-of-the-window view was suitable for attitude control during the firing. He replied that it was, on the day side. "I think you can control your retrofire very well out the window. I don't think it would be any problem at all, [but] I don't think you can do it at night." Ironically forecasting a scenario which could very well have become a reality a year later during Gemini 8, Grissom added, "If you have a contingency landing where you have a retrofire that has to be [viewed] out the window, you will have to do it on the daylight side. This will restrict the contingency landing areas."

Grissom again used the 8-ball for attitude, with rates displayed on the Flight Director Indicator (FDI), which was how he had trained. He later explained that the disturbance from the retrofire had been easier than he had experienced in the mission simulator. The only significant disturbance he noted was when squib number 4 fired, but he was sure that the retrofire practice philosophy during training was the right course to follow. The simulations had provided a number of more severe retrorocket disturbances than they experienced during the real mission, which were then interspersed with several relatively easy retrofire cases, so that when it came to the real retrofire on *Molly Brown*, there were no sudden surprises. Eleven seconds later, the Capcom at Guaymas came on line.

Young: *"Roger, Guaymas. The IVI's readings were 331 aft, 105 right, and 4 up. Right in the center. An automatic, superfine retrofire down the line…and retropack jettisoned"*



Gemini attitude display group, including the '8' Ball indicator which gave Grissom so much trouble during Gemini 3.

"I maintained spacecraft attitude very close to nominal through the firing of the retrorockets," Grissom reported post-flight. "I do not believe pitch or yaw attitude deviated as much as one degree from the nominal retro attitude. I held roll quite close to zero," he added, although this had no direct effect upon the resultant Delta V. The IVIs after completion of retrofire were actually 331 aft, 105 down and 4 right. "The 105 Delta V down was somewhat more than I had ever seen on the Gemini mission simulator," Grissom explained.

PAO Haney: "This is Gemini Control… We have a good retrofire. We have completed it and all indications are that the attitudes were right on. We have an entirely satisfactorily retrofire. This is Gemini Control."

Following the separation of the Retro section, Grissom selected PULSE mode. He found that the system worked as expected and the attitudes were easy to control. "Since re-entry was one of the bigger unknowns," he said after the flight, "I elected to return to two-ring TCS DIRECT after only a brief check of the PULSE mode." The retro-jettison and post-jettison checklists were checked and then rechecked and at GET 4 hours 37 minutes 40 seconds, the Texas Capcom came back into range.

Capcom: *"I'm getting your bank angle times momentarily. Your start of Communications Experiment is 19:05:14 [GMT]."*
Grissom *"Roger. I have steering on the computer… I'm getting bank angles commands from the computer."*
Grissom: *"I'm rolling to 60 degrees left now… I mean 45."*

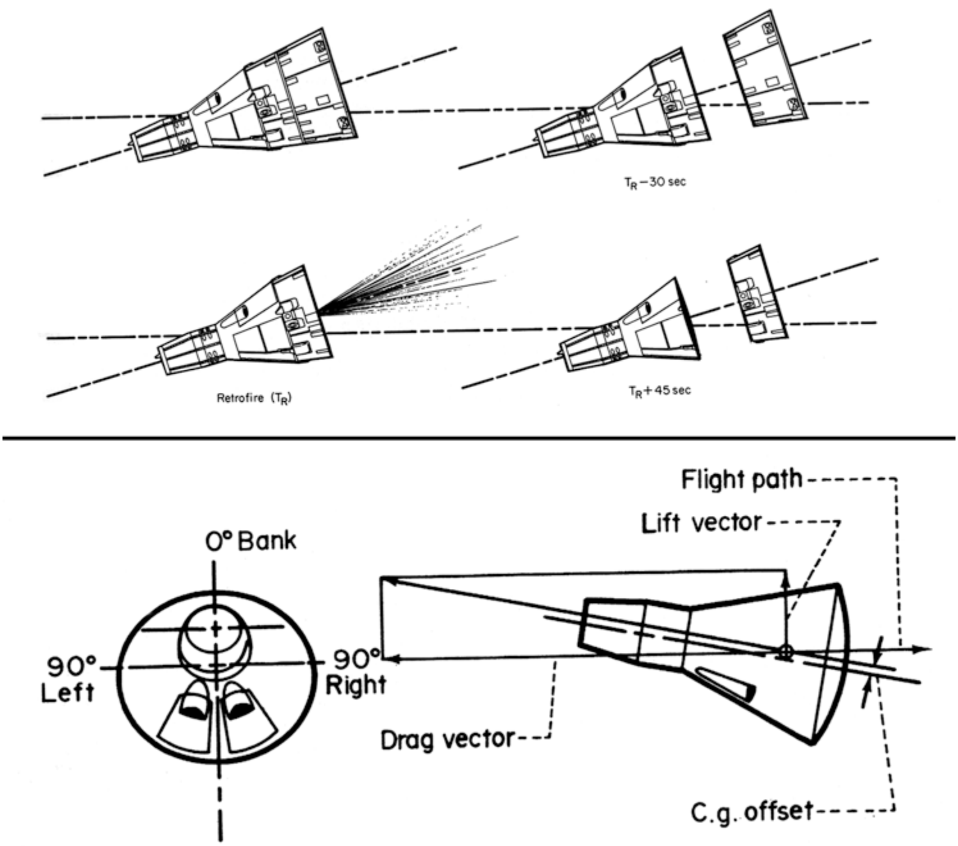
In his post-flight report, Young noted, "We had considerable discussion with the ground at this time on our IVI readings, back up re-entry bank angles, reverse bank angles and re-entry experiment activation times. I wrote this information on the spacecraft walls, having no other convenient place to write." Young was clear that there should be an accessible writing slate at the pilot's fingertips in future, on which to record this essential information. He also recommended that all times of events *after* retrofire should be based on elapsed time from retrofire instead of GMT. This was because both the event timer and the elapsed time clock counted UP from retrofire on Gemini 3.

PAO Haney: "This is Gemini Control. Although communications are a little bit spotty, we were able to hear velocity indications read out by command pilot Gus Grissom. He indicated [that] we achieved 331 ft./sec (100.88 m/sec) retarding velocity. The downward vector was 105 ft./sec (32.0 m/sec). The attitudes were right on at 16 degrees pitch down. This is exactly nominal retrofire maneuver product. This is Gemini Control."

A Lifting Re-entry

"One of the most important advances over the Mercury capsule isn't visible in the Gemini spacecraft," Gus Grissom wrote in *Gemini.* He pointed out that the Gemini was not only capable of maneuvering in space but also after its "howling re-entry phase," as he put it. On Mercury, the spacecraft "dropped like a stone," until its parachute recovery phase, but with Gemini the center of gravity in the spacecraft had been shifted, making the heat shield slightly off-center (1.75 inches (45 mm) from the longitudinal center line) as the spacecraft reached the upper layers of the atmosphere. This made one side of the vehicle 'heavier' than the other and in Gemini's case, the 'heavy' side was away from the hatches and towards the lower part of the crew compartment. This meant that there was just enough lift to allow the glide path to be lengthened "to 350 miles (563.15 km) beyond the planned landing site, or [to] shorten it by 300 miles (482.7 km)," Grissom wrote. He also noted that Gemini could be veered to the left or right by approximately 50 miles (80.45 km). Then, if everything was going as planned, the spacecraft could be rolled at two revolutions per minute to cancel out the lift. Gemini was the first spacecraft to include this capability and it would lead to some remarkably accurate splashdowns later in the program, achieving another of Gemini's long-held objectives.

The Inertial Guidance System (IGS), consisting of an Inertial Measurement Unit (IMU) and a general purpose digital computer, acted as an on-orbit navigational system, both recording the spacecraft's present position and computing the correct retrograde time to provide a safe return at predetermined locations and within the known maneuvering capabilities of the spacecraft, with periodic updates from ground tracking stations. The lift-to-drag ratio was 0.22 and the resulting left vector was amended as required to adjust the re-entry trajectory by controlling the roll of the spacecraft.[2] As the vehicle descended, error signals were generated if necessary by the onboard IGS, to initiate roll response and correct any variation.



[Top] Retrofire sequence and separation of Adapter and Retro modules. [Bottom] Re-entry trim.

[2] The lift-to-drag ratio is a measure of the aerodynamic efficiency of a vehicle and is essentially a 'tug of war' between the forces of flight. In space, only mass (gravity) and thrust (velocity) apply, but within the atmosphere aerodynamic forces apply to the vehicle as well. The *Lift* is the force directed perpendicular to the direction of motion through the air and is created by differences in air pressure. *Drag* is the force directed along the flight path opposite to the direction of motion and is caused by friction through the air as well as differences in air pressure. *Weight* or *Mass* is the force of gravity acting in a downward direction – towards the center of the Earth. *Thrust* is the force produced by the engines that propel a vehicle in the direction of motion.

In the words of the Command Pilot

As this was the first Gemini mission to return with a crew aboard, Grissom recorded a detailed account of his actions for the descent and entry phase of the mission during the post-flight debriefing. [3] “The only thing that was surprising, and wasn’t as I expected it, was the re-entry rate command. Those dead bands were something tremendous. They were on the order of plus or minus 5 or 6 degrees a second. I was glad we had already made up our minds to fly in direct, because those dead bands were just too big. It would have been difficult to control.

“I rolled to the 180-roll, maximum lift attitude, about two minutes after retrofire. At about 4 minutes 30 seconds after retrofire, I started to receive initial steering commands from the computer to hold maximum lift. Prior to retrofire, we had received back up re-entry guidance quantities of a time at 400,000 feet (121,920 m) of 4 minutes 6 seconds after retrofire, reverse bank time of 11 minutes after retrofire and bank angles of 55 degrees left and 65 degrees right. Just prior to communications blackout, we received updated bank angles of 45 degrees left and 55 degrees right, but the new reverse time did not get through.

“I rolled to a left bank of 45 degrees at six minutes after retrofire. Shortly after this, the FDI needle went full-scale, indicating that we were short and to the north of the landing point. The cross-range error started to steer out almost immediately and went to zero about 10 minutes after retrofire. The initial downrange error was about 60 to 70 miles (96.54 to 112.63 km) short. This decreased to about 30 to 40 miles (48.27 to 64.36 km) momentarily and then returned to 50 to 60 miles (80.45 to 96.54 km) and remained there until the computer stopped guiding at 80,000 feet (23,384 m).

“I rolled heads-down, or maximum lift attitude at the time the cross-range error went to zero. The accelerometer was indicating about 1 *g* at this time. I was having some difficulty holding a constant bank angle. The spacecraft seemed to want to drift in roll. Each time I got engrossed in watching the fireball or other phenomenon out the window, the bank angle would deviate slightly. The pitch and yaw rates never did exceed $\pm$ 4 degrees on our rate needles. This agreed very well with the out-the-window views and the rates as shown on the 8-ball.

“The spacecraft was very stable during the re-entry. The DIRECT mode worked very well; control response was quite rapid and accurate. My Flight Director Indicator (FDI) was displaying cross-range and downrange information, where the pilot’s FDI was displaying rates. I flew instruments as my primary reference through re-entry, occasionally cross-checking out the window. Therefore, I did not make many out-the-window observations. I did note that the pitch and yaw attitude is apparent by the material ablating from the spacecraft and that this in itself provides a fairly good spacecraft control reference.

“The re-entry rate oscillations were almost exactly like those that we had experienced on the Gemini mission simulator. The frequency increased and amplitude decreased as *g* increased and just the reverse as *g* decreased. The oscillation frequency seemed to be less than 1 cycle per second. I had no difficulty at all in damping the oscillations. I would check the pilot’s FDI occasionally, or he would inform me that the rates were building up. Usually, one or two controller inputs would damp the pitch and/or yaw rates to zero.

“The *g*-level did not exceed approximately 4 *g*; however, it stayed at 4 *g* for quite a long time (if he had come in at zero lift this would have increased to about 8 *g*). Although I held the spacecraft at maximum lift attitude (± 5 degrees in order to keep cross-range zeroed) during most of the re-entry, the initial up range error indication (approximately a half-scale up needle deflection) did not diminish. The computer still indicated that I was 50 to 60 miles (80.45 to 96.54 km) short at drogue parachute deployment.

"The re-entries that we had flown on the Gemini mission simulator were not very realistic compared to what we experienced on the flight. We had flown several closed-loop re-entries on the simulator but had always been able to alter our touchdown location significantly. Although the re-entry was easy to control, it would have been beneficial to have had a good out-the-window display and to have practiced more re-entry simulations in conjunction with flight-support personnel."

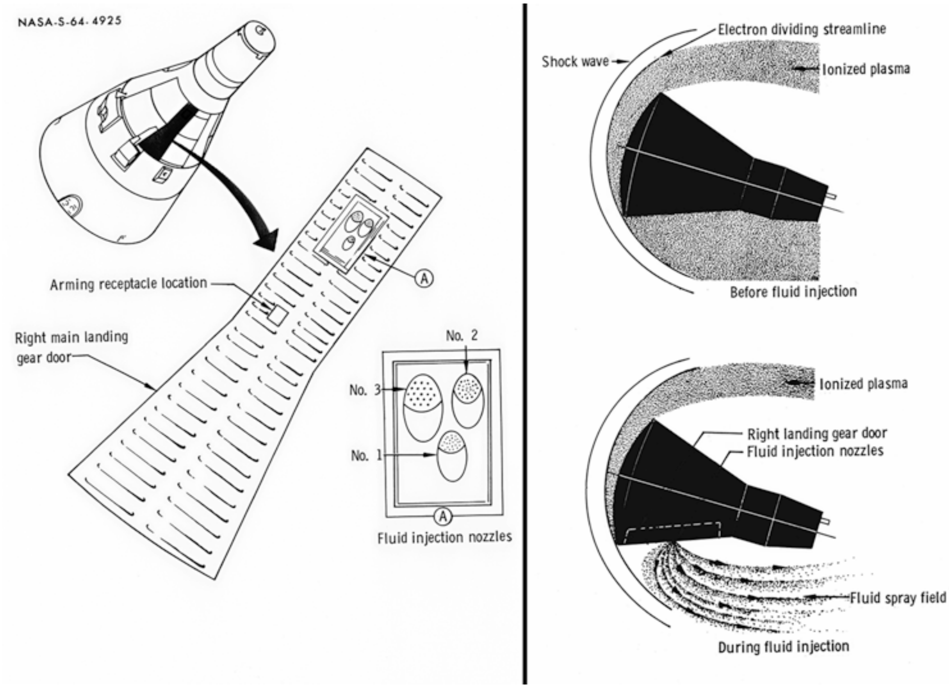
Meanwhile, as he was supporting his commander by cross-checking between the window and the IGS FDI, Young noticed fine particles (which he referred to as "the porkchops") coming off the heat shield in the vicinity of the right Adapter interconnection fairing. As had been observed in the imagery from Gemini 2, these tended to go 'up' over the Rendezvous and Recovery (R and R) Section on *Molly Brown* and as the trim angle was reduced, these particles raised almost vertically from the heat shield. According to Young, the ionized particles were dimly persistent and with his back to the direction of flight, he was able to trace the direction of their re-entry path through the windows, "a long way behind the spacecraft."

As *Molly Brown* plunged through the upper atmosphere, Young could see the jettisoned retro-adapter following them. Both men watched for it to burn up as it entered the atmosphere unprotected. During re-entry, "a film or something suddenly burned off the outside of the window," Grissom reported after the mission. As the plasma dissipated, so the outer window panes of *Molly Brown* were left etched with wrinkle lines over their surfaces, although this did not severely degrade the visibility though the windows. After landing, these lines disappeared, possibly washed off following splashdown. On this, the first of his six re-entries into the Earth's atmosphere, Young reported that, "it seemed to me we held re-entry *g* for a long time, even after we were pitching fairly well vertically."

As the spacecraft re-entered the atmosphere, communications with the ground were lost, with Mission Control hoping that the re-entry communications experiment might give some data during this critical part of the spaceflight.

> PAO Haney: "This is Gemini control. At this time the *Molly Brown* spacecraft is entering the blackout, or the period of ionization. It is approximately over the Florida peninsula [beginning its fourth orbit] and some 17 seconds to go. John Young should have energized the communications experiment; the experiment whereby water will be released in pulses hoping to punch a hole in that sheet that surrounds the spacecraft as it burns through the atmosphere. We are all listening very closely here to see what results will come from this experiment. This is Gemini Control."

In fact, Young had activated the re-entry communication experiment by depressing the activation switch, labeled RE ENT ANT EXP, located on the right-hand switch/circuit breaker panel to the right of his crew station, using the GMT timing called up by the Texas Capcom after retrofire as a start point. He held the PUSH-TO-TALK switch for four minutes from the activation time, trying to communicate with Capcom Gordon Cooper on the ground at the Cape Mission Control.



[Left] Diagram of the location of the re-entry communications experiment assigned to Gemini 3. [Right] Diagram of reduction of the re-entry ionized plasma about a Gemini spacecraft by fluid injection during the latter stages of the Gemini 3 mission.

T-1 Re-entry Communications Experiment

The problem of re-entry communications becoming blocked by the ionized sheath surrounding the spacecraft had been studied for some years by the time Gemini 3 flew. Leading this research was the Langley Research Center, under the Project RAM (Radio Attenuation Measurement) investigation. Initially, the research focused on attempts to understand the problem and predict the radio signal attenuation and this was followed by investigations into alleviating the blackout of communications and measuring the reduced signals under both simulated and actual flight conditions. Adding a material to the ionized flow field yielded the most promising results and led to the flight of the T-1 experiment on Gemini 3.

With *Molly Brown* banked at 45 degrees to the left throughout most of the re-entry blackout period, it was determined that at the prescribed angle of attack that the spacecraft would enter the atmosphere, the water requirements for the experiment would be less if the injection was from the windward side. As the water was injected into its flow field (called the 'window'), it layered and extended from the vehicle's boundary layer out to the shock wave. There were a couple of caveats to flying this experiment on Gemini 3. Firstly, the UHF antenna was located away from the injection, on the aft of the spacecraft and in a separate flow region during re-entry. Secondly, the way the spacecraft flew during the entry, especially during roll attitudes and where signal recovery levels were highly dependent, meant that the water injection window was not pointed towards any ground receiving station.

During the experiment's operation, a number of ground stations located near to the re-entry ground track monitored signal strengths on the UHF telemetry, UHF voice and C-band frequencies (see Table 8.1) At GET 4:36:26 (3 minutes and 3 seconds prior to blackout), Grissom banked *Molly Brown* 45 degrees to the left, placing the ejection nozzles of the experiment about 15 degrees above the horizontal. The UHF blackout began at GET 4:39:59 at about 318,000 ft. (96,926 m) and Young activated the experiment at GET 4:41:16 at an altitude of about 272,000 ft. (82,905m). The experiment ended after 3 minutes at an altitude of about 160,000 ft. (48,768 m) and the blackout period ended at GET 4:45:00 at about 134,000 ft. (40,843 m) altitude, by which time the crew was back in contact with the ground. [4]

Table 8.1 Ground stations used for re-entry communications experiment

	Frequency monitored		
Station	**UHF, telemetry**	**UHF, voice**	**C-band**
Corpus Christi, TX	X	X	
Eglin AFB	X	X	X
MCC (Cape Kennedy)	X	X	
Tel II (Cape Kennedy)	X	X	
MILA			X
Patrick AFB, FL			X
GBI	X		X
Grand Turk Island (GTI)	X		X
Anclote Point	X	X	X
Key West (LRC)	X	X	
Homestead (LRC)	X	X	
Aircraft	X	X	

Information courtesy Gemini 3 Mission Report MSC-G-R-65-2, April 1965 pp. 8-5 to 8-7 & 8-17

Cooper: "Molly Brown*, Cape Capcom. Transmitting you in blackout for communication experiment, over…"* [GET 04:40:10]

Cooper: "Molly Brown*, Cape Capcom. Transmitting you in blackout for communication test, over…"*

Cooper: "Molly Brown*, Cape Capcom. Transmitting you in blackout for communication experiment, over…"*

Cooper: "Molly Brown*, Cape Capcom, with a 1 – 2 – 3 – 4 – 5 – 4 – 3 – 2 – 1."*

PAO Haney: "This is Gemini Control. We are still in the blackout period. Gordon Cooper is following his end of the communications experiment. [He] is broadcasting a long count, in other words a 1-2-3-4 count, repeating it time and again so as to find out what the reception is at spacecraft level. We have as yet heard nothing down here. This is Gemini Control."

For the next five minutes, Cooper continued to try to establish communications with *Molly Brown*.

> PAO Haney: "This is Gemini control. Throughout much of this blackout period we have received C-band data; that is, the data coming in on a very high frequency. It has continued to come throughout most of this period. The mission Director [Kraft] is very much cheered by this. This is Gemini Control."
>
> Then they heard the crew talking …
>
> Young: *"…end of that… …Black Dog…"*[3]
>
> PAO Haney: "This is Gemini Control. Just three seconds ago we got a brief burst of a conversation from Gus Grissom. It sounded like the end of a sentence. Obviously, they have been broadcasting also. We are through the blackout period and I believe momentarily [that] Gordon Cooper and Gus Grissom will establish communications. Grissom sounds [like] his usual husky, deep voice. Cooper querying him again – are you reading – we get bursts back from Gus – they're not too intelligible. Its primarily a carrier problem. This is Gemini Control."

Cooper:	"Molly Brown*, Cape Capcom, over… Go ahead* Molly Brown*… are you reading Cape Capcom now? Over… hello there…* Molly Brown*, Cape Capcom…"* [GET 04:45:26]
Grissom:	*"Roger. We're down to 80,000 feet* (24,384 m) *... My needles show us about 25 miles* (40.22 km) *short."* [GET 04:46:17]
Cooper:	*"I have a rough time; 19.10.42. What's your altimeter reading?"*
Grissom:	*"Reading 60,000* (ft., or 18,288 m) *… there goes the drogue… Okay, we have a drogue…"*
Cooper:	*"Looks pretty good, doesn't it?"*

The drogue parachute was deployed at about 50,000 ft. (15,240 m) as the RCS propellant valves were also turned off.

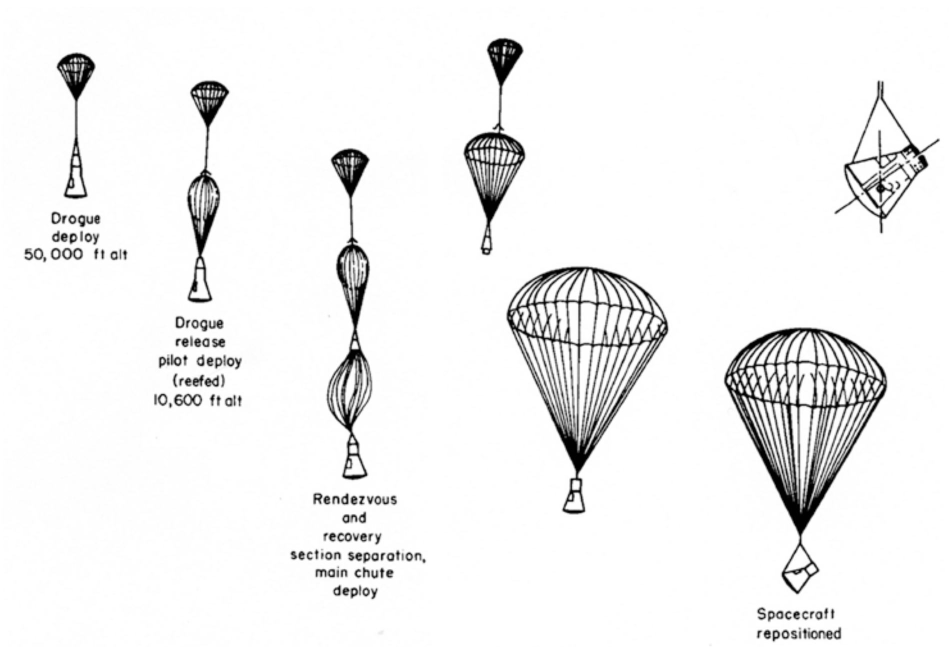
Grissom:	*"Our propellant valves are shut off. We've got a 40K* (thousand ft. or 12,192 m) *light. Really oscillating… passing through 30,000 feet* (9,144 m) *… passing through 13,000* (ft. or 3962.4 m)*."*

As *Molly Brown* descended, the oscillations in the spacecraft increased. Young turned the RCS valves back on so that Grissom could dampen out the oscillations using the RATE COMMAND control mode. The valves were finally turned off at 30,000 ft. (9,144 m), but the RATE COMMAND was left on in order to deplete the fuel and oxidizer lines. Young also opened the inlet snorkel and vented the cabin at 28,000 ft. (8,534 m).

The 40,000 feet (12,192 m) light illuminated very close to the same mark on the altimeter. This was reassuring, as prior to the deployment of the drogue, the altimeter had been

[3] According to the Cambridge dictionary, the saying 'Black Dog' relates to a feeling of depression or melancholy, Perhaps, in this snippet of a transmission which the air-to-ground does not capture in its entirety, Young was expressing regret at leaving orbit and coming home.

very erratic and unreliable. Grissom commented after the flight that, “I didn’t have much confidence in the altimeter, as we went to ‘altitude’ on the launch the altimeter jiggled around and did some funny things. The simulator runs up to 100,000 ft. (30,480 m) and suddenly stops. Well, this thing [the altimeter on *Molly Brown*] quit indicating on launch, at about 80,000 ft. (24,384 m), and stayed there for the rest of the flight.” When the 10,600 ft. (3,230.88 m) mark was reached on the altimeter, the corresponding altitude light also illuminated, whereupon Grissom deployed the main parachute. The parachute remained reefed for eight seconds before it unfurled. Fortunately, to the satisfaction – and relief – of the astronauts, there were no holes or torn panels and “it looked very good.”



The Gemini parachute deployment sequence.

PAO Haney: “This is Gemini Control. We show a main chute indication here in the Control Center… our light indicating main chute is lighted, but we’ve not heard this from the ship or the spacecraft... And the reports from *Intrepid* and the spacecraft now indicate that there is a good main chute, a good main chute deployment. The carrier is in solid communications with the spacecraft. This is Gemini Control.”

Grissom: *“Okay, we have a good stable chute. Going to landing attitude.”* [two-point suspension]

“Beautiful! Just as we expected, everything was just perfect. There wasn’t a thing wrong with that chute,” Grissom recalled. Once he was satisfied that they had a good parachute, they went to landing attitude, promptly giving him the biggest surprise of his life as *Molly Brown* dropped from a vertical position to the 35-degree position: “My head snapped forward with sufficient force to break my face plate on the reticle mounting bracket,” Grissom recalled. At first, the two astronauts thought they had lost the parachute and were plummeting to the ocean. Grissom’s shoulder harness was not locked and they could not determine exactly when they would hit the water or at what attitude. When they got over the surprise, however, both men realized that they were under a good parachute and were heading for a nominal splashdown. They had talked about the position of the reticle knob months earlier but had decided there was no possible way of getting rammed up against it, so they did not worry about it. Fortunately the faceplates were closed, otherwise Grissom thought he would have taken the impact on his face, which could have resulted in serious injury at a critical time in the descent. At this point, all they could do was brace themselves and be as ready for splashdown as they could.

Young: *“Oh man! That was the roughest one of the whole bunch, wasn’t it?”*
Grissom: *“Oh man…Okay. We’re all set?”*
Young: *“Yes. Now we can go through the post-main checklist.”*
Grissom: “Intrepid*, this is* Molly Brown*.”*
Intrepid: *“Roger. We are reading you now and then. How us?”*
Grissom: *“Loud and clear. I have 30 ft./sec* (9.14 m) *rate of descent. Passing through 5500* (feet or 1676.4 m)*.”*
Cooper: “Molly Brown*, Cape Capcom. The carrier has a solid communication lock on you now.”*
Intrepid: *“Your chute is right above us.”*
Young: *“Face plate open?”*
Grissom: *“Open?”*
Young: *“That’s what the checklist says.”*
Intrepid: “Molly Brown*, this is Intrepid. It appears you will land 5 miles* (8.045 m) *ahead of me, over.”*
Grissom: *“Roger. Thank you…”*
Young: *“That’ll be nice. Rescue beacon is on.”*
Grissom: *“Do you have us in sight,* Intrepid*?”*
Intrepid: *“Not yet.”*

In fact, the radar on Intrepid was tracking the descending spacecraft from high altitude right down to the surface of the ocean when the radar elevation angle reached ‘Zero’, thereby identifying the spacecraft’s location relative to the carrier. However, as they were short in their landing, there was no immediate visual sighting, though helicopters were immediately dispatched up range to where they knew Grissom and Young would be waiting in *Molly Brown*. [5]

Young: *“RCS heater’s off. We did not do the heater check. Oh, well, we didn’t need it anyway. RCS temperature was way up. Scanner Heater circuit breaker open.”*
Grissom: *“Do you smell that fuel? Fumes from that stuff?”*
Young: *“Yes. Let’s close up.”*
Grissom: *“Yes. I can see them smoking out there… They’ll get quenched in a minute.”*

Grissom: *"We're coming though the lower layer, John. You'd better get ready to hit. We're at 2,000* (ft. or 609 m). *No telling how far off the altimeter is."* [GET 04:51:29]

Young: *"I'm as ready as I'll ever be."*

Young said that he "went through the post-main checklist about two times. There's no need for a pre-main checklist," he added. "If a guy doesn't know what he's doing coming down from 100,000 feet, he had better not be flying."

Young asked Grissom what he should do for landing, to which the second man to experience a splashdown from space replied: "There's nothing you can do. It's not a very bad jolt when you hit the water." Grissom noted they were in good shape for landing, but with a potentially high O_2 rate in the cabin, he was momentarily concerned about a smell inside. He thought it might be from hot metal after re-entry, but he was sure that nothing was coming out of the thrusters.

Grissom: *"300 feet* (91.4 m). *It ought to be pretty soon now."*

At a GET of 4 hours 52 minutes and 31 seconds, having traveled a distance of 80,000 miles (128,747 km) *Molly Brown* stuck the ocean. They were down but not yet secure, as Grissom knew only too well.

PAO Haney: "This is Gemini Control. We indicate a landing point of 70 degrees longitude, 22 degrees latitude… an aircraft in the prime recovery area is in voice contact with the spacecraft right now and we are assuming he's on the deck and floating… stand by one moment please…"

When asked after the flight if they had been able to determine their horizontal speed at ocean impact, Young typically replied dryly, "That was a good one," and both astronauts said an emphatic "No!"

The landing was in fact remarkably gentle compared to the earlier single-point release, though it was not that gentle according to Young. Neither astronaut could see the horizon, so they had no feel for the attitude on contact, but to Grissom it looked like they were in the correct attitude. Young later confirmed that they were floating nose up at 45 degrees and Grissom recalled that they were swinging on the parachute when they hit the water. For several seconds, Gemini 3 was submerged in the Atlantic, held under by the parachute pulling the nose down 25 to 30 degrees, until Grissom jettisoned the parachute when he saw that both windows were submerged allowing the spacecraft to bob to the surface.

Grissom: *"[I] broke my faceplate when we went to landing attitude."*

Young: *"That was the problem right there."* [referring to the sight mounting bracket extension]

Grissom: *"Look at the smoke coming out of the thrusters… They're off."*

Young: *"I don't understand that… We'd better go to O_2 High Rate and close the snorkel… post-landing checklist. Parachute jet-pushed. Landing safe. Safe the landing bus. Helmet off and stowed. I'd leave it on. Arm restraints…"*

Caught in the wind, the parachute had caused the spacecraft to submerge almost completely, but it had also turned *Molly Brown* around so that the blunt end was facing the wind. As the thrusters emitted their toxic yellow smoke, that wind was now carrying it away from the spacecraft. The crew closed the snorkel for a brief period as they noticed some grayish smoke and fumes inside the crew compartment, which they thought was from the hot shingles.

Grissom:	"*This is* Molly Brown *in the water. Anybody read?"*
Aircraft:	"Molly Brown*, this is Big Box 15. You are loud and clear. Check with Big Box 14.*"
Grissom:	*"Roger. We're floating well in the water."*
Aircraft:	"Molly Brown*, Big Box 15. We have a jumper about 10 yards* [9.14 m away from the spacecraft], *second jumper on final* [approach]."

PAO Haney: "We have had a visual sighting by an aircraft in the area; we're standing by for additional information. This is Gemini Control."

PAO Haney: "This is Gemini Control. Additional reports coming up from downrange now giving us a new plot of some 60–65 miles (96.5 to 104.5 km) northwest of the *Intrepid* and our latest advisory says there's a Coast Guard cutter, called the *Diligence*, within perhaps 10 miles (16.09 km) of the spacecraft. At this time, we only have one visual sighing report from an aircraft in the area. The Navy, of course, is very busy comparing plots, radar information, onboard information and within a very few minutes we hope to have a little more solid information on how the spacecraft looks. The general ground rule says that the pilots will remain with the spacecraft until the ship comes alongside. Stand by one."

The aircraft were communicating with the spacecraft in voice; another had been receiving UHF-DF frequencies one minute after *Molly Brown* hit the water

Young:	*"Okay, Shoulder fitting stowed. Got the cabin light off. Helmet – off and stowed. Arm restraints stow. Helmet off and stowed?* [Young questioned] *I don't think we ought to do that.*"
Grissom:	*"No, not yet."*
Young:	*"Arm rest stow. Okay, elbow rest stow; lap belt release and stow."*
Aircraft:	"Molly Brown*, Big Box 14. Go ahead."*
Grissom:	*"This is* Molly Brown*, Big Box 14. Go ahead."*
Aircraft:	*"Roger, sir. If you will give me a 15-second hold-down*." [A command to Grissom to depress the communication trigger, allowing the search aircraft to lock on to their position.]
Grissom:	*"Okay I will hold it down."*

The Recovery Aircraft then asked for a second hold down.

Aircraft:	*"Okay,* Molly Brown*, I've got a fix on you. Big Box 14."* [GET 05:00:26]

Then, thirteen minutes after the spacecraft's splashdown and twenty-five minutes after it had left *Intrepid*, an aircraft arrived above the spacecraft and deployed the Para rescue men.

Down in the water, the spacecraft did not leak at all, at least as far as Grissom and Young could tell. It floated nicely with very little roll, unlike the Static Article #5 they had used in training in the Gulf of Mexico, which frequently rolled to the right. There was no water washing over the two windows of Gemini 3. Grissom was told at this point that the Para rescue men would be with him soon and he saw one of them drop into the water some 20 yards (18.28m) in front of the spacecraft's nose: "But I did not see the other Para rescue man until the collar was attached and he walked past my window," he wrote later.

Then they received an update from Cooper at the Cape.

Cooper: *"It will be about 50 minutes before the carrier is there."*
Aircraft: *"Understood... one in the bag and two in the drink."*

In his post-flight report, Young noted they were in contact with the recovery ship via UHF radio, but received conflicting reports on their distance. Initially, they were told they were five miles (8.04 km) away, then 55 miles (88.49 km) away. "This led to conflicting times as to how soon it would be to be recovered," he said, then added, "It is essential to get out of the pressure suit as soon as you land if there is to be any delay in recovery." He also observed that "it was important to position all spacecraft controls, switches and safety pins as soon as possible because I noted seasickness reduces crew efficiency."

> PAO Haney: "This is Gemini Control. In the last few seconds, we've had our confirmation from downrange that one of the Air Rescue airplanes circling the area had deployed its paramedics, or its jumpers. Their purpose is to go down and secure the spacecraft with a large floatation collar to assist it. This is Gemini control."

Officially, the splashdown of *Molly Brown* in the Atlantic Ocean was recorded in the vicinity of Grand Turk Island at the coordinates of 22.43 degrees North and 70.85 degrees West. The flight of the first manned Gemini had ended successfully. *Molly Brown* was home … but not yet dry.

References

1. **Gemini!** Virgil 'Gus' Grissom, Macmillan, 1968, p. 112.
2. *Pilot Report*, Astronaut's Flight Report, March 31, dated 1966 (but probably 1965), M-913-65-03.
3. *Command Pilot Report*, Astronaut's Flight Report, March 31, dated 1966 (but probably 1965), M-913-65-03.
4. Manned Space Flight Experiments Symposium, Gemini Missions III and IV, held at the Auditorium of the Museum of Natural History, Washington D.C., October 18-19, 1965, NASA, Experiment T-1, Re-entry Communications on Gemini III, pp. 81-103.
5. Press Breifing, Charles W. Mathews, NASA New Release MSC, 65-65 May 3, 1965, p. 10.

9

The Unsinkable *Molly Brown*

"It was a great spacecraft,
but it was no boat."
John Young, recalling the
seaworthiness of Gemini 3.

As *Molly Brown* hit the water, Gus Grissom's mind flashed back to his previous splashdown on *Liberty Bell 7* and the problems resulting from that prematurely-blown hatch. In his posthumously-published book on the Gemini program, Grissom wrote that his first thought upon hitting the water in *Molly Brown* was "Oh my God! Here we go again." He explained that Gemini had been designed to have the left, Command Pilot window – his window – ride high out of the water, but instead of a view of blue sky he found himself looking down into the ocean depths. Once he jettisoned the parachute, however, *Molly Brown* righted itself, no doubt much to his relief.

John Young has commented that while *Molly Brown* may have been a great spacecraft, it made for a lousy boat as it bobbed around in the Atlantic swell. He later wrote in his 2012 memoirs that he had little trouble coping given his navy experience aboard destroyers, but that his air force officer colleague Grissom became sick. Grissom wrote that it was "as hot as hell" in the spacecraft and though Young held on to his last meal, Grissom lost his in short order. It was not that the water was especially choppy, rather that the heat inside the spacecraft was uncomfortable. Grissom was concerned that he might vomit all over the spacecraft and his suit, missing the bag in the swell, but Young quickly unstowed the larger right-hand empty food box for his commander to use. Grissom did not take any anti-motion sickness medication and later reported that he was not nauseous prior to landing, putting his sickness down to the motion of the spacecraft on the water and the warm conditions inside.

To help ease their discomfort while they awaited the arrival of the aircraft carrier to pick them up, they took off as much of their pressure suits as they could, but were initially unable to get the communications lead out as the wrench to undo it was back in the aft food box. Young took the door off to access the wrench and used to disconnect the comm lead, while Grissom simply cut his leads. Taking off their suits was no easy task in the tight confines of Gemini as it drifted in the ocean and it took them another thirty minutes of

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_9

struggling before they were finally clad only in their long-john underwear. When they learned that it was going to be up to 90 minutes before the recovery vessel reached them, they decided to request a helicopter pickup.

The floatation collar and dinghy had been in position for some time and the Para rescue team, U.S. Navy Underwater Demolition Team (UDT) frogmen Gilbert A. Timone and Raymond C. Blache, assisted the crew out of the spacecraft. One of the scuba divers worked on Grissom's hatch. "I started to do it, that hatch handle [but] I couldn't make it work," Grissom explained. "I pulled and heaved on the handle, but I never got the thing open." He checked it three times to ensure he had the levers in the unlock position and, not wishing to break the hatch, he finally returned the levers to the neutral position and let the scuba diver unlock the hatch from the outside. He had been told earlier that a new hatch seal had been installed, which increased the force required to lever the handle from 35 to 45 lbs. (15.8 to 20.4 kg).

Both Grissom and Young had inflated their 'Mae West' life jackets as they got out of the spacecraft and Grissom started to take the life raft out of the survival kit, until Young indicated the three or four life rafts attached to the floatation collar and he got into one of those instead. As Grissom's 300-lb. (136 kg) hatch was clear of the water, he was helped out of *Molly Brown* first. Young noted that this was a change to Navy tradition, in which the Captain was always the last to leave his ship. It took Grissom only a split second to think about that before promptly verbally promoting Young to Captain. Young responded by deciding to re-christen his vessel as the USS *Molly Brown.* The helicopter hovered over them and lowered a horse collar to the raft. Grissom put it under his arms and they hoisted him aboard, followed a short time later by Young.

Young (in raft at right) awaits helicopter pickup, with Para rescue divers in attendance.

With their constant wear (underwear) garments beneath a robe and wearing life preservers, Grissom (left) and Young reflect on their accomplishments over the previous five hours on board the recovery helicopter, while en-route to the USS *Intrepid*.

A BUSY WEEK

Once inside the helicopter, each man was given a regulation blue navy bathrobe for the trip back to the *Intrepid,* which made Grissom think they looked like a couple of guys who had just had a big night at a convention rather than astronauts returning from space. A flight surgeon also gave each of them a preliminary examination during the helicopter ride and radioed back to Mission Control that all was well. Their spaceflight may have been over, but they were about to embark on a very busy week of post-flight activities and receptions.

Tuesday March 23 – Post-Recovery

> PAO Haney: "This is Gemini Control. The helicopter bearing Gus Grissom and John Young is now over the deck of the carrier *Intrepid*. Momentarily, it will touch down and the red carpet has been spread out on the deck of the *Intrepid*. I'm advised literally thousands of white-suited sailors are deployed around the deck ready to cheer the arrival of these two spacemen. This is Gemini Control."[1]

[1] Haney's comment implies that there were considerably more onboard than the actual complement for *Intrepid* (as built) of 2,600 officers and enlisted men, which was not the case.

Grissom and Young arrived on the deck of the carrier in the helicopter at 15:30, approximately seventy-two minutes after they had splashed down. Dressed in their navy-issue bathrobes and in the stocking feet of their constant-wear garment, they looked as though they had emerged from a hospital convalescent ward rather than America's latest spacecraft, but as Grissom stepped out of the helicopter he had a big smile on his face, waving to the crowd of sailors thronging around the helicopter. A smiling Young followed him a few steps behind and both men were obviously happy to be there.

After the tension of the re-entry and splashdown, Barbara Young was told that her husband and Grissom had been picked up by helicopter after an hour floating in the ocean and had been taken to their aircraft carrier wearing nothing but their underwear. She reportedly commented, "If they walked out of the helicopter in their underwear, it must have been a sight to see." [1]

Back on *Intrepid*, the two astronauts were met by Rear Admiral Donald M. White and the current skipper of the *Intrepid*, Captain Joseph Grant-Smith, with the rest of the ship's crew perched on every available vantage point to glimpse the two astronauts. Following a brief reception by the ranking officers onboard, Grissom and Young continued their rather busy day below decks, including undergoing another preliminary medical examination which concluded with the report that both men were in excellent condition.

Meanwhile, the now vacant, but precious – and indeed, proven unsinkable – *Molly Brown* was picked up by *Intrepid* at 17:03. This must have been a great relief for Grissom, who could not now be accused of losing a second spacecraft.

Informally dressed astronauts (in their underwear and still shoeless) receive a warm welcome from the crew onboard the USS *Intrepid*.

U.S. NAVY RECOVERY FLEET

The following is a summary of the U.S. Navy forces that were engaged in the recovery operations for the first three Gemini missions under the test-flight program. For further details on Naval recovery of U.S. manned spaceflights in the golden era of 1961 through 1975, the reader is directed to the excellent work by Don Blair in his 2010 book *Splashdown.* [2]

Gemini 1 – unmanned orbital test flight – remained in orbit, destroyed upon re-entry – no recovery planned. However, the DoD still deployed 5,176 men, 11 aircraft and 3 ships in support of the mission.

Gemini 2 – unmanned suborbital flight – recovered capsule in 1 hour 30 minutes.
DoD support: 6,562 men, 67 aircraft and 16 ships
Atlantic recovery force (10 vessels): One prime recovery carrier USS *Lake Champlain* (CVS-39); six destroyers USS *O'Hare*, (DD-889), USS *Forrest Royal* (DD-872), USS *Eugene A. Green* (DD-711); USS *Holder* (DD-819), USS *Putnam* (DD-757), USS *Vogelgesang* (DD-862); two ocean Minesweepers USS *Agile* (MSO-421) and USS *Bulwark* (MSO-425); and the fleet ocean tug USS *Paiute* (ATF-159)

Gemini 3 – manned orbital test flight (3 orbits) – recovered astronauts in 1 hour 12 minutes and capsule in 2 hours 47 minutes.
DoD support: 10,185 men, 126 aircraft and 27 ships.
Atlantic recovery force: (20 vessels): One prime recovery carrier USS *Intrepid* (CVS-11); the heavy cruiser USS *Boston* (CA-69); nine destroyers, USS *Bigelow* (DD-942), USS *Douglas H. Fox* (DD-779), USS *Harold J. Ellison* (DD-864), USS *Harwood* (DD-861) USS *Mullinix* (DD-944) USS *Rich* (DD-820), USS *Robert L. Wilson* (DD-847), USS *Robert A. Owens* (DD-827) and USS *Ault* (DD-698); two anti-submarine destroyers, USS *Cony* (DD-508) and USS *Sarsfield* (DDE-837); the guided missile destroyer USS *John Paul Jones* (DD-32); two ocean minesweepers USS *Sturdy* (MSO-494) and USS *Swerve* (MSO-495); the oiler USS *Kankakee* (AO-39); the cutter USS *Diligence* (WMEC-616); the fleet ocean tug USS *Nipmuc* (AFT-157); and the gunboat USS *Vigilant* (WPC-617).

To support as well as recover Gemini 3 from the ocean, it had taken about 10,000 personnel, 27 ships and 126 aircraft (see sidebar: *U.S. Navy Recovery Fleet*). This force had been strategically deployed to ensure a rapid response and recovery in case of either a pad abort, the failure to achieve orbital flight, or the termination of the mission after one or two orbits, as well as for the nominal three-orbit plan and any contingency which may have occurred along the ground track of the spacecraft from launch to splashdown. As with Project Mercury, this method was proving very effective, but it was also highly expensive each time a mission was flown.

An invitation to the White House

One of the formal appointments for the crew after splashdown was a talk with President Lyndon B. Johnson, by telephone from the White House. On the way to receiving that historic call, Grissom reportedly kept telling the Public Affairs Office that "it was a great flight," and, with an even bigger smile, that he was "ready to take Gemini 4." Speaking by radio-telephone from his office in the White House, President Johnson spoke directly with Grissom and Young on board the USS *Intrepid* in the Atlantic: [3]

> "Gus? This is Lyndon Johnson. How are you? We have all been following every moment of your flight today since lift off this morning, and I wish I could have been there to meet you as I was when John Glenn took his." [2]

The President then expressed the pride of the nation at the success of the mission and the safe return of both men, which had confirmed the vital role that man had to play in the peaceful exploration of space. He then continued:

> "I remember, Major [Grissom], some very anxious moments you had and we all lived through with you on *Liberty Bell* [referring to Grissom's previous spaceflight in July 1961]. Today, apparently, *Molly Brown* was as unsinkable as her namesake and we are all mighty happy about it."

The President then acknowledged their work, which would continue with briefings before a well-earned rest and he expressed the hope that both astronauts would journey to Washington that Friday (March 26) so that he could extend the welcome of all Americans to them. After receiving the President's congratulations on their dedication and devotion to duty and the space program, as well as his best wishes to both of them and their families, Grissom thanked the President, adding, "We had a very thrilling and wonderful flight today." He then passed the phone over to Young, who added, "It was a wonderful ride." President Johnson then echoed the relief of having both men safety home and Young, in the excitement of his first spaceflight, replied, "Boy! The only thing wrong with it, it didn't last long enough." The President replied that they would try and work that out for him in the coming days and closed with a salute, both to the two of them and "all the folks who work with you. Please know you have the Nation's admiration and gratitude."

The White House also released a *Statement by the President on the Flight of Gemini 3* and on the achievements of Grissom and Young. The President stated: "On behalf of an appreciative and admiring Nation, I am proud to extend congratulations for Virgil Grissom and John Young on their successful flight and safe return. … We can be especially proud that our orderly program for space exploration is producing the successes we have hoped

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[2] President Johnson was referring to a previous meeting with John Glenn at Grand Turk Island in February 1962 when, while he was Kennedy's Vice President, he accompanied the astronaut back to the United States after Glenn's historic three-orbit mission as the first American astronaut to orbit the Earth.

Soon after their recovery and below decks on *Intrepid*, Grissom receives a call from President Johnson while Young looks on awaiting his turn to speak to the President.

for and [as] we had planned them. Today's flight is an impressive testament of our fine talent… on this important first step of Project Gemini. To all who have contributed to this endeavor, I want to say, 'Well done'." [4]

As the current National Aeronautics and Space Council (NASC) Chairman, Vice President Hubert H. Humphrey added his congratulations during his visit to Cape Kennedy for the day, commending all those who had participated across the world "for this tremendous flight of three orbits." [5] The Vice President added: "This step forward commits us to the next project. Once we have completed the Gemini series, we move on to the Apollo Project and we move on even beyond that." With another nine Gemini missions still to go and most of the program's objectives yet to be attained, even before flying the first Apollo mission, the Vice President made the bold statement:

> "Let me say that the American economy is better because of the space program. American education is better because of the space program. American industry is better because of the space program and Americans are better because of the space

> program. We are emphasizing here [one] great characteristic of American life – excellence, performance, achievement … These are efforts well made and money well spent."

Meanwhile, back on the USS *Intrepid*, the two astronauts had begun the program of extensive physical examinations, but they had the chance to shave, bathe and change into more comfortable clothing before going to look at the now-recovered *Molly Brown*.

According to Grissom, a 'debriefing' was "one of those service terms that give English professors the willies." [6] It involved a series of verbal accounts of the mission, taped for later scrutiny and compared to the data collected during the mission. It was important to capture the crew's recollections from the mission as soon as possible while the events were still fresh in the memory, to ensure that no details were overlooked or even forgotten, which was likely to happen if it was left until a couple of days – or even a few hours – later. The personal debriefings would continue the next day. In his memoir, Grissom recalled that unlike a detective novel in which characters were supposed to "spill their guts" to the interrogators, neither he nor Young expressed any major gripes, although there were some points both men felt strongly about. According to Grissom, "*Molly Brown* had done everything we'd asked of her, with a fast submarine ride thrown in for free."

Over 45 years later, John Young's memoirs also noted the hours of debriefings that followed the flight of Gemini 3, recalling, "It took about three days to go through our onboard tapes and edit them. There were plenty of corrections to be made. We'd listen and laugh, listen and laugh." Even listening to the tapes very carefully, the commentary on the various situations was only obvious to the two astronauts, who had been, figuratively speaking, 'on the ground' and could appreciate that situation, as well as what had not been said and the context of what had been recorded. [7] Young recalled that one significant event which was recorded well was the splashdown, which on the tape reminded him of someone throwing a large rock into water. Except that following the 'splash', there had been a lot of cussing, as it was a rough landing. After the mission, they went to McDonnell to try to replicate the rough impact in a special fixture and attempt to develop procedures to avoid it. But none of the tests apparently came close to their actual experience and, in all the subsequent splashdowns of Gemini and Apollo Command Modules, none came close to replicating how hard *Molly Brown* had struck the water, according to Young.

Initial inspection revealed that *Molly Brown* had survived its short journey remarkably well and the subsequent post-flight inspection revealed nothing out of the ordinary. There was no evidence of excessive high temperature on the outer surface, which looked remarkably clean with no significant hot spots. Compared to the heat shield on Gemini 2, that of *Molly Brown* was whiter in appearance, which was related to the different ablation processes that had occurred on both vehicles. There was more heat during re-entry on Gemini 3, but it was over a slower, longer period than on Gemini 2, which had followed a much steeper and shorter entry. Gemini 2 had shown far more external evidence of charring than was visible on *Molly Brown*. According to Chuck Mathews, in the subsequent press conference on May 3, "We have very considerable margin in this [Gemini] heat shield."

The post-flight medical data gathering lasted for about 48 hours after *Molly Brown* had splashed down, mainly via clinical and laboratory examinations. The post-flight findings revealed mild dehydration of both crewmembers and minimal decrease in pulse during tilt tests. The medical team onboard the *Intrepid* consisted of a surgeon, an anesthesiologist and a surgical technician. They were supported by a Medical Office Flight Surgeon back at the Manned Spacecraft Center.

If they thought rigors of the spaceflight were challenging, then further challenges awaited the two astronauts with the detailed examination completed in the ship's sick bay aboard *Intrepid*. This program included taking further samples of blood for the S-4 experiment, tilt-table studies and a comprehensive general examination which encompassed the following investigations: vital signs, eyes, nose, throat, ears including audiogram; neck, thorax, spine; neurological examination including position sense; lungs, heart, abdomen; extremities with maximum measurements; PA and lateral chest X-rays; electrocardiogram, complete blood count and urinalysis. After all these investigations revealed only evidence of mild dehydration, it seemed both men were none the worse for their spaceflight.

The use of the tilt table replicated the investigations that L. Gordon Cooper underwent after the flight of Mercury-Atlas 9 two years earlier. Baseline blood and heart rates were established with the astronaut lying prone on the litter for five minutes. Then the litter was titled to the 70 degrees head-up position for the next 15 minutes, followed by a return to the horizontal position, where restabilization occurred after another five minutes. During the three tilt-table studies prior to launch, continuous ECG and respiratory readings were taken, in addition to intermittent blood-pressure measurements. On the recovery vessel, the two tilt table tests were completed with only continuous ECG monitoring. On the first test, both crewmembers recorded an increase in heart rates and a decrease in pulse pressure, but for both the second tilts their levels were almost the same as for pre-flight tests. Necessity required these pre- and post-flight tests to be conducted by different people in different locations and the mild movement of the recovery vessel had to be taken into consideration, but given that, the post-flight report noted that "such a response was not expected after a mission of such short duration. The significance of such findings is not known at this time and must await further evaluation." [8]

Following their first period of debriefing and medical examinations, Grissom retired at about 21:30 and Young at 23:00. It had been a very long, exciting, rewarding, but tiring day. Well, it had been rewarding except in the financial sense, according to Associated Press, who had worked out that their day's pay for March 23 had been $37.25 for Grissom and $32.75 for Young, totaling just $70. [9]. Further individual medical debriefings of Grissom and Young were conducted aboard *Intrepid* the next morning (March 24) and with both crewmembers after returning to the launch site on the second day after the mission (March 25).

Ninety minutes after the astronauts had landed on the *Intrepid's* flight deck in the Atlantic, a post-flight news conference with NASA and DoD officials was held back in Florida, at the press site at Cape Kennedy. Those participating were: [10]

- Dr. Robert C. Seamans, Associate Administrator, NASA
- Dr. George E. Mueller, Associate Administrator for Manned Space Flight, NASA
- Dr. Robert R. Gilruth, Director Manned Spacecraft Center,

- Christopher C. Kraft Jr., Assistant Director, MSC for Flight Operations and the Gemini 3 Mission and Flight Director
- Dr. Charles Berry, Chief of MSC Center Medical Programs
- Maj. Gen. Vincent G. Huston, Assistant DoD Manager for Manned Space Flight Support Operations and
- Maj. Gen. Ben I. Funk, Commander, Air Force Space Systems Division.

All the officials present were delighted at the success of this first manned mission of the series, as well as the performance of the Titan launch vehicle, the spacecraft, the flight crew and the support staff on the ground. Muller stated that the flight of Gemini 3 had been notable in many ways. As the first manned flight in the series, it represented an important step in assuring the success of the other missions. For the first time, a spacecraft had been maneuvered in orbit, while another first was the demonstration of control during re-entry. Muller also highlighted the use of the Syncom communication satellite via CSQ throughout the mission.

Chris Kraft stated that the astronauts seemed to have no significant problems in controlling the systems in the new spacecraft, despite some minor issues. The Environmental Control System was given a good workout for its first operational use and, according to Kraft, could not have performed any better. The cabin and suit temperatures matched what had been experienced in previous vacuum chamber runs and the subsystems performed extremely well during the mission. On the whole, the propulsion system also worked very well, with accelerations and the durations of each burn achieving close to the nominal values. Despite the small drift to the left in yaw, the attitude control system also performed well, which was important for the forthcoming rendezvous and docking missions.

Mathews also commented on the excellent performance of the spacecraft and although this was a short flight, he believed it offered the opportunity to proceed with Gemini's program: "We see no major bulwarks in the way to going into our operational phase of the program," he told reporters, before adding, "There are things we are going to have to look into before the next flight. We have to look at the data before we can say what this means to us, but certainly we didn't have any major perturbations on this flight. At no time was any serious difficulty involved." Finally, Charles Berry summed up the medical aspects of the mission. He confirmed that no unexpected readings were recorded from either astronaut with regard to their body temperature, blood pressure, respiration or heart rates.

Wednesday March 24 – A day of debriefing

The following day, still aboard the *Intrepid*, Young got up at 06:30 and Grissom ten minutes later. Both had breakfast of milk, apple juice, coffee, eggs, sausage and toast before beginning another series of long debriefing sessions.[3]

[3] These debriefing notes were later released by NASA as Gemini Working Paper #5025, dated June 3, 1965.

During the evening of their first full day back on Earth following their mission, the two astronauts addressed the assembled ship's company on the hanger deck, thanking them for their part in the recovery. Meanwhile, a quarter of a million miles away, NASA's latest lunar probe was making its own headlines.

Another small step towards the Moon

On the day after Gemini 3 flew (March 24), having traversed a quarter of a million miles, Ranger 9, travelling at 5,977 mph (9,616.9 kph), successfully impacted the lunar surface as planned at coordinates 12.9 degrees South latitude and 2.4 degrees West longitude. The spacecraft had successfully transmitted 5,814 close-up images of the lunar surface, starting from a distance of 1,300 miles (2,091.7 km) from the Moon and including images of small objects defined as about 10 inches (25.4 cm) across a few seconds prior to its destructive impact.

Later that day, after watching the televised pictures of the lunar surface transmitted by Ranger 9, U.S. President Lyndon B. Johnson congratulated the team which made this such a successful program. "Ranger 9 showed the world further evidence of the dramatic accomplishments of the United States space team. Coming so close after yesterday's Gemini success, this far-out photography reveals the balance of the United States space program," he said, before continuing, "Steps toward the manned flight to the Moon have become rapid and coordinated strides, as manned space maneuvers of one day are followed by detailed pictures of the Moon on the next." [11]

And a longer stride further out

The next day, in the euphoria of a busy week of space exploration, NASA revealed that Mariner 4, launched on November 28, 1964, had now journeyed nearly 40 million miles (64.3 million km) from Earth, travelling at 30,000 mph (48,270 kph) relative to the Sun. On its journey to the red planet Mars, where it was expected to fly by at its closest approach on July 14, Mariner 4 had traveled approximately 188 million miles (302.5 million km) in its own orbit around the Sun.

Thursday March 25 – Press conference

Early in the day, the crew and other support staff flew on a U.S. Navy aircraft from *Intrepid* to the 'skid strip' at Cape Kennedy to meet their parents and the press. They then went to the Bio-Astronautics Support Area (BASA) at the Cape, where they were greeted by their wives and children. This was a family reunion none of them would ever forget. Grissom and Young then underwent more thorough physical examinations – a four-hour physical similar to their pre-flight examination – conducted by Dr. Berry, Dr. Gordon Benson, Dr. Eugene F. Tubbs, Dr. John F. Ziegleschmid and Dr. Howard Minners. The two astronauts also spent several hours with engineers in technical debriefings.

Two days after their mission (March 25), the astronauts were flown from the carrier to the Skid Strip at Cape Kennedy. Clearly pleased to be back on American soil, they are seen addressing the gathered members of the press prior to rejoining their families.

Later in the afternoon, the two astronauts and their families led a parade in open-top convertibles from the Cape to the Carriage House Motel at Cocoa Beach, for a press conference in the aptly-named Gemini Room at 17:30. This motel had also served as the Gemini 3 news center, staffed not only by NASA personnel but also by representatives from the U.S. Air Force and the U.S. Navy. In attendance were about 1,000 news media, from across the United States and a number of foreign countries as well, who had been assigned to report on the flight and cover the press conference. [12]

Participating in this conference were:

- Dr. Robert C. Seamans, Associate Administrator, NASA
- Gus Grissom, Command Pilot, Gemini 3
- John Young, Pilot, Gemini 3
- Dr. Robert R. Gilruth, Director, MSC, Houston, Texas
- Christopher C. Kraft Jr., Assistant Director for Flight Operations, MSC
- Dr. Kurt H. Debus, Director, Kennedy Space Center, Florida and
- Julian Scheer, Assistant Administrator for NASA Public Affairs.

The press conference was opened by Dr. Seamans, who gave the background to the Gemini program and highlighted a number of individuals who were key to the program but had been unable to make the news conference. This included Dr. George Muller, who was responsible for NASA's manned spaceflight program and was the Program Manager for Gemini and Dr. Harry Goett, the Director of the Goddard Space Flight Center in Maryland, who was responsible for the tracking and data acquisition during the flight.

Robert Gilruth spoke next, confirming that the booster and spacecraft had both performed well and that "this was a very clean flight, and Gus and John brought back a wonderful set of test data on all the various systems and various maneuvering capabilities." Gilruth revealed that Grissom had said earlier that they had endured a peak of about 4 *g* during re-entry, whereas a ballistic re-entry topped 8 *g*. Gilruth added, "This is a very significant thing and gives some of the old timers like myself maybe a chance that they will be able to stand the rigors of space travel… in the future." Kurt Debus thanked the men and women who worked at the Cape, as well as the U.S. Air Force team headed by Colonel Jack Albert which was responsible for preparing the Titan II, the Assistant Director for Spacecraft John Williams who was responsible for the performance of *Molly Brown* and F. Merritt Preston, who was responsible for the launch preparations, together underlining the massive team effort that supported the two astronauts who flew the mission.

Then Grissom and Young spoke about their experiences and the mission, describing it as routine and very enjoyable. Grissom commented, "This is another one of those occasions where I don't mind appearing before the press," candidly hinting at the reception he had received following his *Liberty Bell 7* mission. He confirmed that, for both of them, "it was a pretty heavy day" and that they had not expected *Molly Brown* to perform so well on this first manned flight. Both men then went on to describe their mission and experiences to the enthralled audience. Then each man introduced his family to the audience. Grissom asked his wife, two sons and mother and father to stand up in turn, then Young did the same for his wife, two children, his parents and his wife's parents. They were all very proud of what their husbands/fathers/sons had achieved over a few short hours and after many months of hard work.

The floor was then opened for questions from the media. The first questioner asked the astronauts what was next for both of them in the program. Grissom responded by saying that both of them had been occupied with the mission for 24 hours a day for most of the past year and that their immediate task was to get the full report completed. After that, perhaps they might get a few days off, "to go skiing or something."

The next questioner noted that, "rightly or wrongly," both of the astronauts had been portrayed as introverted, shy and sometimes down compared to some of the others. However, their performance at this news conference indicated that maybe "space travel is likely to turn you into a happy extrovert." Before this press conference, both Grissom and Young had been criticized in the media for being too reserved, but there was a lot riding on the success of their mission and both were consummate professionals. Now that the mission was over, both were able to open up a little. Grissom replied that "It [space travel] could do it I believe," while Young, who would gain a reputation for his exceptionally dry and quick wit over the next four decades, gave an early indication of that at this press conference. He quietly replied, "I think zero-g would make an extrovert out of anybody."

The press conference held on March 25 at the Carriage House press site, Cocoa Beach, Florida. Left to right: Dr. Kurt H. Debus, director of KSC; Christopher C. Kraft Jr., MSC assistant director for Flight Operations; astronaut John W. Young, Pilot Gemini 3; astronaut Virgil I. Grissom, Command Pilot Gemini 3; Dr. Robert R. Gilruth, MSC director; Dr. Robert C. Seamans, NASA associate administrator; and Julian Scheer, assistant administrator, Office of Public Affairs, NASA.

Grissom highlighted the importance of maneuvering a spacecraft in orbit as opposed to performing a spacewalk, as the reporters referred to Leonov's achievement completed the week before they flew. That was not to take anything away from the Soviets because there were plans for astronauts to perform EVA as well, but to Grissom, flying the spacecraft, changing orbit and guiding its re-entry were far more important steps. Young added that comparing the two was like comparing apples and oranges. They were two different things, but both would be important for the broader program.

Grissom replied to a question of weight loss on this flight compared to *Liberty Bell 7* (in which it was reported that the astronaut had lost about three pounds (1.36 kg) during the 15-minute flight), stating that he and Young were a little dehydrated, probably as a result of the humidity and lack of room in the spacecraft after they were in the water. Grissom told the audience that he had been advised that he had lost two-and-three-quarter pounds (1.24 kg) during GT-3. Young agreed that it was during the time they were floating on the ocean: "We got up to 95 degrees in the capsule and we were really sweating before we took our pressure suits off. We waited too long to do that. We should have taken them off immediately. Without any spacecraft cooling aboard, you are going to overheat in it.

I think you have to get your space suit off. That is just one of our operations problems [to overcome].”

The questions that followed asked the astronauts about what they could see from orbit, both in celestial observations and down on the ground. With regard to the night sky, Young said, “The first time I looked out of the window, I saw the Southern Cross, Alpha and Beta Centauri and the constellations of the south. The next time I looked out of the window I saw Orion’s Belt, Capella and the Northern Sky, the Pleiades. The stars are just as easy to see out there as they are here.” Grissom added, “I think I saw what I am sure is a planet and probably Venus on the first [orbit] before we went into darkness for the first time.” Later, a reporter asked if they were able to observe details such as automobiles, trucks and smoking chimneys, as Cooper had reported being able to do during MA-9. Grissom replied that they only had one clear area in northern Mexico for observations, but were kept busy aligning the sight to determine if the control system they had was good enough to track objects. “I think that I could see streets down there in the city, but I wouldn’t want to swear to it right now,” he said. They were then asked to comment about the success of the Soviet cosmonauts in what the reporter called “Sunrise II [meaning Voskhod 2].” Grissom appreciated their efforts, complementing the Russians on their performance and stating, even though no one had actually seen the Voskhod, “I certainly envy the large spacecraft they have.”[4]

Dr. Seamans stepped in at this point when comments were made about the quality of TV from Voskhod 2. He stated how proud they all were of the American hardware they had and that NASA was not lagging in developing its own TV from space. He then cited what had been accomplished in the last 48 hours: “As you know yesterday [March 24] from the Ranger pictures [approaching the Moon], we used the Tiros for weather [imagery] and the Syncom for communications. We certainly think that the Russian people should be proud of their program. We are mightily proud of *our* program and we are not going to take a back seat to anybody.” This generated a huge applause from the gathered audience.

The questions then turned to the crew’s training and the astronauts were asked whether they thought that, after their experience, the training time could be cut down from the year that Grissom and Young had completed for this flight. Grissom replied that they had been hard pressed for trainers since the start, “so the [other astronauts] will get as much as they can, anytime. If you can be assigned to a flight a year, or two years in advance, you are that much better off – you get that much better prepared for it.”

With regard to how well the spacecraft had performed on the mission, Grissom stated, “I think this means that we are ready to go ahead and use it operationally as we had planned to, that this flight showed that the systems worked. They worked as we expected them to work. The booster will do the job that we had expected it to and so now we can go ahead and use it as an operational vehicle.”

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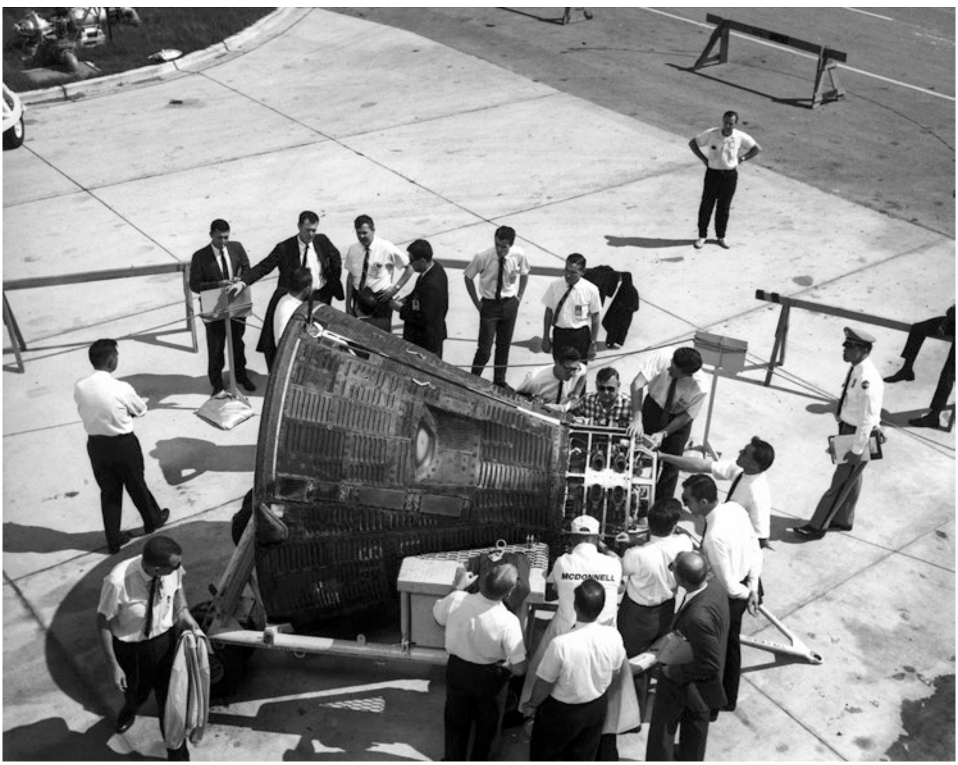
[4] No one outside the Soviet space program was aware at this time that Voskhod was not the step forward that the Soviets wanted everyone to believe. It was not a new, large spacecraft, but was instead a stripped down Vostok. It had no rescue capability, was limited in duration and did not have a maneuvering system. The mission was dangerous (for the crew) and essentially motivated by propaganda, rather than the technical advances of performing the first, limited EVA.

A questioner then referred the original plan to land Gemini on the ground as opposed to in the water and whether Grissom thought he could have landed *Molly Brown* on dry land if he had to. He replied that, from the information he had seen, he did not think he would want to: “That would be a pretty brutal shock.” Dr. Seamans then pointed out that if they had to come in over land, the astronauts would have to eject and use their personal parachutes.

To a question about the comfort of the new spacesuit, Grissom commented that it was more mobile and quite a bit more comfortable than the Mercury suit he had worn on *Liberty Bell 7*. There was now a neck ring that moved the helmet when the astronaut turned their head, as well as improved wrist rings. Young added that it was a very reliable suit and that a similar model would be used for EVA on a future flight.

This naturally raised questions about plans for EVA, longer flights and more experiments, but these were deferred by Dr. Gilruth who stated, “I think these questions were answered pretty well by Chuck Mathews at the press conference right after the flight. We are going to do all we can to cover these milestones as fast as we can.” A complete answer would have to be deferred until all the data from Gemini 3 could be analyzed, but at this point there did not seem to be any obvious obstacles to going ahead with the planned program.



On March 25, two days after flying its mission the ‘*Unsinkable Molly Brown*’ arrives back on dry-land at Cape Kennedy.

Another question from the reporters focused upon the fact that Gemini was designed to fly for up to 14 days. As *Molly Brown* was the only flight with operational experience to date, Grissom and Young were asked how they thought a crew could sustain a two-week mission and what the main operational hazards would be on such a flight. Grissom stated that he thought it would be possible to do a 14-day mission, but quickly added, "John's anxious to do it. I'm not." Clearly, he was already looking towards Apollo after completing his Gemini assignments. Grissom also thought that the biggest problem a 14-day crew would face would be housekeeping, in keeping track of all the loose items floating around the cabin. Young added that the biggest advantage of flying a 14-day mission would be doing so in zero-g: "It would be impossible in one-g," he acknowledged. The question was revisited later in the press conference and Grissom replied that the only thing he would do for two weeks was "maybe go skiing or something," not particularly fly a mission.[5] Young commented, "It'd be an interesting challenge. I'd like to tackle it."

Part of the problem of remaining inside the Gemini for so long without "cracking the hatches" and going on EVA would be the restricted movement within the cramped spacecraft. Even attempting basic isometric exercises would be challenging. Grissom noted that on Gemini 3, Young completely released his seat belt and shoulder harness so that he could turn to reach the food boxes and that he moved around a great deal. Young admitted that it was very difficult to simulate this in one-g, "but it's a piece of cake in zero-g."

One interesting question during the press conference concerned the lack of crew commentary on the air-to-ground tapes and transcripts. The reporter asked: "This is the first time that we got two men in space and that's probably a good reason why there is a limited air-ground activity. But your own conversations up in the air – were these monitored at all times by the ground and if not, did you have the conversations completely taped – and for the information people, will that conversation be released?"

Grissom admitted that: "No, our conversations in the air weren't monitored by the ground – the only things that were monitored were what we transmitted to the ground. Most of our conversations on board were recorded, *but not all of them. We have the capacity of turning the recorder on and off as we please* [author's italics]." The reporter was not totally satisfied and asked again if the tapes would be released. Julian Scheer interjected: "I'm sure in the final flight report that the tapes will probably be released. They have been in the past, in all the Mercury flights." The press conference ended shortly afterwards.

This was an interesting statement, revealing that what was read in the air-to-ground commentary did not include all that was spoken during the mission. This, in fact, is not surprising, because the crew would have been aware that the tapes would eventually be released and they would not want every personal comment, observation – and perhaps frustration and irritation – to be clearly transcribed for all to criticize. As mentioned earlier, Young commented in his 2012 biography that, "it took us about three days to go through the onboard tapes and *edit them* [author's emphasis]." This observation is backed up by a comment in Tom Stafford's 2002 biography *We Have Capture*, written with Michael Cassutt, in which he recalls "Listening to the tapes later, we were all amused by

[5] The exception, perhaps, would have been a mission to land on the Moon and while Grissom was unaware that he was less than two years away from his planned third mission (Apollo 1), that mission was ironically developing into a 14-day open-ended flight.

Gus and John's language. It was as if they had spent nearly three orbits cursing. '*Goddam'* this, *'where the hell is'* that, *'son of a bitch'*. And when they had their electrical problems, it really got blue." It would be interesting to hear those original tapes now, to truly learn about the realities of conducting a pioneering spaceflight in the mid-1960s!

While all these activities at the Cape were going on, the *Intrepid* eventually arrived the same day (March 25), with *Molly Brown* on board, at the Newport Navy Port in Jacksonville, Florida, where the spacecraft was off-loaded. Once its systems had been fully deactivated, *Molly Brown* was airlifted to the Cape, arriving at the skid strip at 19:15 before being taken to the Cryogenics Facility at Merritt Island prior to undergoing extensive post-flight examination.

Friday March 26 – Mission to the White House

On this, the third day after their mission, the contingent of astronauts, their families and support staff flew to Washington D.C. to meet President Johnson. The original plan had been for the ceremonies to be held in the Rose Garden of the White House, but events were moved to the East Room because of heavy rain. Here, the President presented the NASA Exceptional Service Award to Grissom, Young and Dr. Seamans. The change of venue prompted President Johnson to observe: "We intended to conduct this ceremony this morning in the Rose Garden. However, Major Grissom and Commander Young found their landing in Washington this morning only slightly less wet than their landing in the Atlantic Ocean on Tuesday." [13]

The astronauts are shown here leaving the White House after ceremonies there on March 26. Left to right are: John Young, Senator Mike Mansfield, Vice President Hubert H. Humphrey, Gus Grissom and President Johnson.

The President then recalled the sense of history in that famous room of the White House and the achievement of America's tentative, experimental first steps into space. It had only been four years since Grissom had flown his first mission and the President noted: "We have come very far in a very few short years. Yet the quickening pace of our advance will carry us far beyond this point of achievement even before one more year passes." He then added, pointedly referring to the Soviets, "The program we pursue now is a planned and orderly program but with one purpose – the purpose of exploring space for the service of peace and the benefit of all mankind here on this Earth. We are not concerned with stunts and spectaculars, but we are concerned with sure and steady success."

Grissom was also awarded a cluster to the Distinguished Service Medal he had received for his first spaceflight in 1961, highlighting that he had become the first person to fly in space twice. The families also met with the First Lady, Mrs. Claudia Alta 'Lady Bird' Johnson, as well as Vice President Hubert Humphrey. Grissom later recorded that the visit had made a lasting impression on his two young sons. After the White House celebration, the group took a motorcade down Pennsylvania Avenue to the Capitol, where a Capitol luncheon, a visit to the Smithsonian Institute and, later, a Congressional reception were held. They were the first astronauts to visit the U.S. Congress in an official capacity. Late on Friday night, the astronauts and their families flew back to the Cape to spend the weekend at Cocoa Beach.

Saturday March 27 & Sunday March 28 – Cocoa Beach, Florida

On March 27, as the astronauts and their families relaxed in Florida, the Soviet newspaper *Izvestia* (Russian meaning '*Delivered Messages*' but usually translated as '*News*' or '*Reports*') disclosed that the Gemini 3 astronauts had congratulated cosmonauts Pavel Belyayev and Alexei Leonov on their Voskhod 2 mission and on Leonov's success in conducting the world's first spacewalk a few days prior to their own mission.

Monday March 29 – Newark and New York

It was back to the post-flight tour on Monday morning, as the astronauts and their families flew to Newark, New Jersey, to be greeted by officials at City Hall on their way to New York City, New York. Despite a hard, driving rain when they arrived at New York's LaGuardia airport, they were treated to a traditional tickertape parade down Fifth Avenue, Broadway. Despite the low temperatures, the astronauts rode in an open-top limousine together with Vice President Hubert Humphrey, acknowledging the thousands of well-wishers who had turned out as they were showered in tickertape confetti thrown from the windows of the buildings lining the route.

At City Hall, the procession stopped for a brief ceremony, where the Mayor, Robert F. Wagner, presented the Keys of the City to Grissom, Young, Dr. Seamans and the wives of all three. The group then visited the United Nations and were guests of honor at an official New York City Reception held at the Waldorf-Astoria, where Mayor Wagner presented the New York Gold Medal to Grissom, Young and Dr. Seamans for their achievements.

With umbrellas covering the crowds and braving the elements in New York riding in an open topped car (left to right) Gus Grissom, Vice President Hubert Humphrey and John Young acknowledge the huge crowd. (Credit: World Wide photos/NASA)

Tuesday March 30 – Chicago

The next day, Grissom and Young were accompanied by their wives and Grissom's two sons as they flew to Chicago for another round of ceremonies, together with NASA's Deputy Administrator, Dr. Hugh Dryden.[6] These post-flight public tours were significant events in the 1960s and for many of the astronauts and their families, they were perhaps more daunting than the actual mission into space. They often drew huge crowds and major coverage in the local papers. In the mid-1960s, so-called 'Moon-fever' was gripping the nation and the recent successes of the Soviets, such as Voskhod 2, as well as the unmanned Ranger 9 lunar photographic mission, were frequently used by the press to provoke national fervor over the perceived race to the Moon against the USSR. In part, this served to deflect the increasingly negative headlines from south east Asia and the simmering domestic tensions arising among ethnic minority and student groups. While not everyone was in awe of what the astronauts were trying to accomplish, coverage of the trip to Chicago by the Gemini 3 astronauts, their families and the NASA contingent clearly

[6]Young's two children remained at home in Houston for this trip recovering from a bout of chicken-pox. Another infectious disease, German measles, would feature in John Young's astronaut career four years later, during preparations for Apollo 13.

portrayed the sense of adventure of these early flights into space and the affection for those who were risking their lives to conquer that frontier.

After arriving at Chicago's O'Hare Airport, on a chilly, overcast day, the entourage traveled by motorcade to City Hall. It was estimated that over one million people witnessed the procession. As well as the astronauts, Hugh Dryden and their families, the cars included Governor Otto Kerner and a number of State, County and local officials. Images reproduced in the Chicago Tribune the following day showed packed sidewalks either side of La Sale Street as the 15-car cavalcade drove through. [14] As the procession proceeded, the crowds increased and broke through the police cordon, excitedly reaching out to touch the two men and get a better look at America's latest space heroes. At times, the procession almost halted, such was the enthusiasm of the crowd, but members of the Chicago Black Horse Troop cleared the way for the car containing the astronauts. The parade held up the general traffic for over an hour, but no one seemed to mind, with motorists who were caught up in the mayhem blasting their horns in salute to the astronauts.

Council Mayor Richard J. Daley presented the two astronauts and Dr. Dryden with medallions as special guests of the City and conferred the title of Honorary Citizen on all three. In recognition of the warmth of the reception, Young spoke to the crowd, stating that they had been told Chicago would be chilly, but he suggested that it was 120 degrees in the shade, which received a huge ovation. Young also said "I think that *Molly Brown* made this country look good around the world, and as the saying goes," he continued, referring to the next steps in the program, "they ain't seen nothing yet."

By now, it would be reasonable to assume that the astronauts were getting used to the adulation they were receiving, but it seems that both remained a little embarrassed by all the praises coming from city dignitaries. They did raise a smile when it was stated that, after their civic welcomes here and in New York and Newark, New Jersey, the astronauts would probably have preferred to be back in orbit as they were just a week before, rather than going through all this. Hugh Dryden received another large cheer, however, when he stated the weather was better and the crowd bigger in Chicago than it had been "in a certain city in the east."

Later, at both an official luncheon for 200 diners in the Blackstone Hotel and a further reception at the Sherman House for 2,500 guests, the astronauts were asked questions by groups of selected students from Chicago schools. At the luncheon in the Blackstone, Grissom was called upon to give a speech and raised laughter when he informed the diners that "there are certain responsibilities and authority that goes with being commander of the *Molly Brown*. So this time, I'm going to call on John Young to make a speech." To the audience, it became clear that Young had no idea this was going to happen and he had not prepared any notes. After a few moments to gather his thoughts, he offered the following impromptu, but perfectly delivered presentation:

"We've got 26 or 28 astronauts and any one of them could have flown this flight and done a credible job. The people who deserve the credit are those welders, electrical engineers and flight engineers who have been working seven days a week. These people are irreplaceable. Money can't buy them. They were so devoted to their jobs that Gus and I knew we'd make it before we had even taken off."

Governor Kerner complimented both astronauts on their wit and speeches. He asked Grissom, "who writes your stuff?" Grissom smiled and pointed to Young, replying, "John does."

Later, during the event in the Great Ballroom of the Sherman House, the astronauts were asked about 30 questions by the students in two groups over the course of about an hour. The questions pulled no punches and neither astronaut attempted to dodge a fair reply. The questions ranged from the lack of female astronauts in the program at that time, to why their spacecraft landed off target, their reaction to the Russian success in performing the world's first spacewalk and the problems of long-duration spaceflight.

To the question of female astronauts, Grissom said that he did not expect to see any female astronaut candidates any time soon and though female pilots did a great job during WWII, he did not see the need to include women in the astronaut corps just because they were women. A decade prior to NASA actively issuing a call for female astronaut candidates for the Space Shuttle, it was clear that, at least with this veteran astronaut, their inclusion should be on qualifications, experience and attainments grounds, not solely on gender.

Grissom also expressed a personal feeling regarding the mission which was not apparent in the more formal post-flight reports. To the question of whether he was nervous about the flight, he explained that he did not exactly have butterflies, as the student had asked, but that just prior to lift-off he did have a little anxiety: "To tell the truth, I was more nervous this time than on my first trip. This time, I was the commander of a ship and was responsible for John's life, too. It's quite a responsibility," he admitted. Young then replied to a question about his thoughts on being in orbit for the first time. "It's just about the most satisfying experience you've ever had in your life. I can't wait to go back out there," he said.

The sessions ended with a surprise for Grissom, when his third-grade mathematics teacher at Mitchell High School (Indiana), Miss Mildred Hopkins, appeared for an unexpected reunion. Grissom brought tears to the eyes of his former teacher when he introduced her and credited her with giving him such a good start in mathematics. Later, Miss Hopkins confirmed that Grissom was a fine student who always completed his work on time and was often ahead and asked for further work. Following another busy day, the astronaut party retired to their rooms at the Drake Hotel before finally returning to Houston the following day.

Wednesday March 31 – Houston

After departing from O'Hare Airport at noon, the group arrived back in Texas at Houston Intercontinental Airport. Although their mission had lasted less than five hours, Grissom and Young had been way for two weeks, having left for the Florida launch site on March 15. They were greeted at the airport by the Mayor of Houston Louis Welch (who presented both men with keys to the city), NASA and civic officials and approximately 1,000 students. They then travelled to the City of Houston where an estimated crowd of 12,000 greeted them, including school children, as the local schools had been closed early to allow the students to greet the returning astronauts. The two astronauts walked along a long line of well-wishers at the front of the crowds, shaking hands with many of them. Grissom told the enthusiastic crowd that "We've had a pretty tough week, then came a couple of days debriefing, then three parades, but today is the best of all – when we got to come home." Young added: "We're sure happy to see all you smiling Texans." [15] After a special reception, they were finally allowed to return to their homes near the Space Center. Their task now was to try to readjust back to a normal domestic life, as focus centered on the next Gemini crew to fly. (In the April 16, 1965 edition of MSC Roundup, this ceremony was quoted as occurring on April 2.)

One of the last formal post-flight ceremonies for Gemini 3 was held on April 1, outside Building 1 at NASA MSC, Houston. Left to right are: Paul Haney, Public Affairs Officer; Bill Schneider, Deputy director of the Gemini Program; Chuck Berry, Chief of Medical Programs; Chris Kraft, Assistant Director of Flight Operations; George Low, Deputy director of the Manned Spacecraft Center (out of view behind podium); Charles Mathews, Gemini Program Manager (also out of frame); Dr. Robert R. Gilruth, Director MSC, at the podium; astronaut Virgil I. Grissom; astronaut John W. Young; Maxime A. Faget, assistant director for Engineering and Development; Deke Slayton, assistant director for Flight Crew Operations; and Wesley Hjornevik, Associate Director for manned spaceflight at MSC. (Courtesy Ed Hengeveld)

Thursday, April 1 – Manned Spacecraft Center

At noon, the astronauts participated in yet another, thankfully short ceremony at MSC, where a U.S. national Stars and Stripes flag was raised. This flag was made of silk by members of the parachute support section of MSC's Technical Service Division and had been carried aboard Gemini 3. Dr. Gilruth announced that this flag would be flown at MSC during all future Gemini missions. Gilruth praised the symbolism of the national flag and that it was now raised in tribute to new milestones in spaceflight, including those recently achieved by Gus Grissom and John Young and "all the other persons who worked long hours for the success of the first manned Gemini flight." Grissom and Young both thanked those at the Center who had helped make the flight as successful as it had been. Then Young said, "One of these days, we're going to bring a flag back from the moon," prophesying the time, almost exactly seven years later, that he would plant a Stars and Stripes on the lunar surface as Commander of Apollo 16.

With this event completed, eight hectic days of debriefings, physical examinations, tours, awards, speeches and dinners – and several airport visits – came to a close. Though most of the public duties were completed, Grissom and Young would still have to attend a series of formal debriefings and discussions about their mission and experiences with the rest of the astronaut group. The date the 'Gemini Stars and Stripes' flag was lowered, pending the next Gemini mission, was not recorded.

WINDING DOWN FROM GEMINI 3

Four days later, on April 5, NASA announced that Gus Grissom and John Young would be the backup crew for Gemini 6, the first Gemini rendezvous and docking mission. The prime crew for that mission, as expected, would be Walter M. 'Wally' Schirra, Jr. as Command Pilot and Thomas P. Stafford as Pilot. [16]

On April 15, the KSC Spaceport News edition reported that Vice President Hubert Humphrey had written to compliment Cape Kennedy technician Richard Tennis on his diligence in resolving the problem with the oxidizer leak on the first stage of the GT-3 launch vehicle shortly before launch. "I understand that you are the gentleman who corrected the problem," wrote the Vice President. "I simply wanted to express to you the thanks of all of us here in Washington who have watched so carefully the success of this program. It is the excellent work and quick efforts of people like yourself that have made this program so successful." [17] This praise echoed the sentiments expressed by Young a few days earlier in Chicago, emphasizing the huge team effort required in preparing each mission to fly, then launching and supporting the flight through to splashdown and post-flight operations.

On April 21, the New York Times reported that NASA had absolved Gus Grissom of any blame in being 58 miles off target in the landing of Gemini 3. The discrepancy, which is the one thing that probably prevents the flight being called a 'text-book mission', had been traced to the lack of lift that the spacecraft had developed and the investigation commented that Grissom may have banked the spacecraft improperly as the result of a misunderstanding over an instruction from a ground station. [18] The re-entry error was caused by erroneous results from the wind-tunnel tests conducted prior to the mission, in that the tests were not capable of providing a truly definitive answer to the question of the lifting capability profile of the spacecraft. This error and its cause contributed to the misreading of the Gemini's capability to maneuver during the atmospheric re-entry at the end of the mission. The crew had been instructed to fly a bank angle based on that wind-tunnel data, but the lift produced during the actual re-entry was only two-thirds of that expected to be attained. The onboard instrumentation had shown this discrepancy, but Grissom initially followed instructions received from the ground. When he finally did change the angle, it was simply too late to achieve the desired target point landing.

The post-flight analysis had also determined that the cause of the slight left drift in yaw was due to a spillage of water from the water boiler, creating a slight but discernable thrust. The problem was solved when Grissom switched from the water boiler to the space radiator. The electrical short in a convertor was the only electrical failure in over 20 miles of wiring and the thousands of electrical components installed on *Molly Brown*. This problem was solved by switching to the backup systems, justifying the need to have an effective redundancy system built into the development of the spacecraft. [19]

John Young Day

On Saturday April 24, John Young and his wife Barbara returned to his home town of Orlando in Florida for a day of celebrations. Their two children remained in Houston, being looked after by a baby-sitter. In recognition of his achievements, April 24 was designated 'John Young Day' in the city, which had also organized a specially-struck medal, the John Young Award. This would be awarded in future years, though not necessarily every year, to honor Orlando residents for outstanding achievements. [20]

Although Young had been born in San Francisco in 1930, his family moved to Orlando later that decade, where his father had found work. Young and his brother grew up here and thus the astronaut has always considered Orlando to be his home town. Now, just over a month after becoming only the sixth American, 17th person and 16th male to orbit the Earth, Young was back in Orlando for the celebrations. [21]

For the three-mile trip through down town Orlando, the Youngs were joined in the car by Vice President Humphrey. Yet again, the enthusiastic crowds were large, with a festival atmosphere, an estimated 10,000 people lining the route, several bands playing, Boy Scouts releasing hundreds of balloons and scores of children waving welcoming banners as the convoy passed by. One of the bands, from Young's old junior high school, played, suitably, '*The Unsinkable Molly Brown*', while another band played '*Anchors Aweigh*' for the Naval officer and his wife as the city's guests of honor.

A 15-car cavalcade weaved its way through the streets, with Young's father and stepmother, Florida's Governor Haydon Burns and his wife, the Vice President's wife, the State Democrat Senator George A. Smathers, House of Representatives Republican Edward J. Gurney and other civic and government officials filling the other cars. The Mayor of Orlando, Robert S. Carr, told the astronaut that the whole city was "bursting with pride" for their famous citizen, as he presented him with the inaugural 'John Young Medal'. Responding to the huge crowds, Young said, "I truly appreciate all the people in Orlando who endowed me with the qualifications to become part of the space program." Later, the party attended a luncheon with Governor Burns, who presented the astronaut with a State of Florida plaque. Later still, the Youngs visited a lakeside picnic, with some of the astronaut's former Orlando school friends as guests. Young and his wife returned to Houston the next day.

On May 3, Young, then a Lt. Commander in the United States Navy, was presented with the Navy's Astronaut Wings by the Secretary of the Navy, Paul H. Nitze, at a formal ceremony at the Pentagon in Washington D.C. [22] Earlier, in recognition of his achievement in becoming a flown astronaut, Young had also received the NASA Astronaut Gold Pin, awarded at a special Astronaut Office 'Pin Party.' The Gold Pin is issued to mark an astronaut's first spaceflight, complementing the Silver Pin that each astronaut is awarded upon their selection to the program. On the same day, Gemini Program Manager Charles W. Mathews revealed that the results of the blood cell experiment flown on Gemini 3 showed no indication of irradiation in the human blood cells. [23]

John Young is awarded the U.S. Navy astronaut wings on May 3, presented by the Secretary of the Navy, Paul H. Nitze at the Pentagon, Washington D.C. (U.S. Navy image)

MOVING ON

In other developments, a NASA press release issued on May 19 revealed that the recovered Gemini 2 spacecraft, which had flown a suborbital mission on January 19, 1965, was to be returned to the prime contractor McDonnell and then delivered to the USAF in July 1966, for an unmanned suborbital flight to test the reworked Gemini B heat shield design. That design now incorporated a crew transfer hatch that would allow military Manned Orbiting Laboratory (MOL) pilots to transfer from the Gemini to the laboratory and back again. [24]

As the month of May drew to a close and with the Grissom/Young and Schirra/Stafford teams working on the Gemini 6 mission, most of the focus now turned to the next Gemini mission, the four-day Gemini-Titan 4 flight of Jim McDivitt and Ed White. But there would be a swansong for the Command Pilot of Gemini 3.

Hometown honors for Grissom

On May 30, it was Gus Grissom's turn to be honored with a parade, in his home town of Mitchell, Indiana. [25] These tours were a triumphant climax for all the hard work and long hours the crews had put into their missions. It was also good for the astronauts to see the adulation and praise shown to members of their immediate family, for their continued support and dedication in keeping the home running while the men of the house were away on their missions. But as Betty Grissom wrote in 1974, "this period boiled down to days of nervous tension, tired feet, and separation from my husband. The politicians always rode with the astronauts. The wives came along behind, and then the children." [26]

It wasn't all negative though. During the trip to Chicago, Barbara Young had found the reception "wonderful" and was in admiration of the sheer number and enthusiasm of the children lining the parade route and at the ceremonies. The Grissom sons must also have been impressed with their ride in the convertible behind their father, with their own names printed on the side of the vehicle. At City Hall, the astronauts' wives were exalted along with their famous husbands, with one council leader acknowledging the "trying situation for the real power behind these men." Alderman Thomas Keane, the City Council floor leader, added, "We know you have given them the encouragement and patience and the compassion so that they could carry out their work." The responses of the two wives to such comments were not reported. [27] Also accompanying the Grissoms at the Chicago events were the astronaut's parents, Mr. and Mrs. Dennis D. Grissom and his younger brother Mr. Norman Grissom and his wife. Norman Grissom noted that the whole day had been "pretty hectic."

Flying the flag in promoting Gemini achievements

As June approached, with the launch of Gemini 4 just a few days away, it would not be long before confidence in the Gemini system would be put to the test once again. On June 3, 1965, the day Gemini 4 lifted off, the homemade U.S. Stars and Stripes flag that had been carried onboard *Molly Brown* was hoisted once again outside Building 1 (Administration Building) at the MSC, at the exact moment Gemini 4 entered orbit. That flag was to be flown only while astronauts were in space, it was reported. [28] In fact, there were two flags hoisted that day. The second, also carried onboard Gemini 3, was the first documented program flag celebrating the Gemini program. It featured the blue, gold and white Gemini program emblem on a light blue background and, like the national flag, was made of lightweight parachute nylon. Both were fabricated by the Parachute Support Section of MSC's Technical Service Division. The two flags were both flown together for the duration of each Gemini mission, starting with Gemini 4. At the end of the Gemini 12 mission, the flags were lowered for the final time and retired to a special display case in the lobby of the center's auditorium. For many years, the Gemini flag remained on display in the MSC Museum located behind the auditorium in Building 2.[7] [29]

On June 22, 1965, President Johnson nominated John Young for promotion to the rank of Commander from his current rank of Lieutenant-Commander, a position he had held since 1961.[8] Earlier that month, the President had been in Houston and had announced the promotion of Gus Grissom from Major to Lieutenant-Colonel, USAF, among others. [30]

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[7] Following the construction of a new visitor center, Space Center Houston, the museum in Building 2 was closed down and the exhibits, including the Gemini flag, were placed in storage. Unfortunately, after years in storage the historic significance of the flag was apparently forgotten, or it was loaned for some unrecorded exhibit on Gemini, because its current location is unknown.

[8] Wally Schirra was nominated for promotion at the same time as Young, to the rank of Captain, USN. Like Young, Schirra had been in his present rank – in his case Commander – since 1961.

Apparently, NASA Administrator James Webb had not been happy when he had been told that Gemini 3 was to be named *Molly Brown* and then when he learnt of the corned beef incident, he tried to block the customary post-flight promotion in rank.

Automatic promotion was not something that was a feature of the Mercury flights but during President Johnson's June 11 visit to the Manned Spacecraft Center following the Gemini 4 mission, he mentioned nominating the Gemini 4 crew of Jim McDivitt and Ed White for promotion. In his speech, he also mentioned that Gordon Cooper was to be promoted to the rank of Lieutenant Colonel on July 15 and that he was going to nominate Gus Grissom for promotion to the same rank. [31] Betty Grissom watched the event on TV and was relieved to hear that her husband's contribution and achievements were being recognised and that he would be promoted as well. [32]

A gigantic outpouring of goodwill

By the time the Gemini program drew to a close some eighteen months later, Gus Grissom had not flown on Gemini again but was instead preparing for his third spaceflight as Commander of Apollo 1. He was also completing the draft of his book *Gemini*, which was published about a year after his untimely death in January 1967.[9] Looking back at the program of tremendously successful Gemini missions, Grissom wrote that each had received increasingly less acclaim than his first mission had drawn. He summed this up by stating, "I can understand the reason behind this gigantic outpouring of goodwill John and I received for our relatively easy flight. After all the Russian spectaculars, the United States was back in the manned spaceflight business with probably the most sophisticated spacecraft in the world, or out of it [at that time]. Our reception was the public's way of expressing pride in a nation's achievement." [33]

If it had been possible and NASA had asked Grissom and Young to take *Molly Brown* back in to space the day after splashdown, Grissom wrote that they would have done so with pleasure. "She flew like a queen, our unsinkable *Molly Brown*, and we were absolutely confident that her sister craft would perform just as well." [34]

References

1. *"He's on his way…and it couldn't be prettier*, Miguel Acoca, in *Gemini's Journey*, Life Magazine, April 2, 1965, pp. 34-42.
2. Data sourced from **Splashdown, NASA, The Navy and Space Flight Recovery**, by Don Blair, Turner Publishing Company 2010, pp. 37-38 and pp. 192-193.
3. Lyndon B. Johnson, 36th President of the United States, 1963-1969, Item #120, Telephone call with Gus Grissom and John Young following the orbital flight of Gemini 3, March 23, 1965, The American Presidency Project, http://www.presidency@ucsb.edu, last accessed August 7, 2017.

[9] The *Gemini* book by Grissom was a project by Field Enterprises and World Book Encyclopedia, probably sanctioned by Time-Life but not produced by them, as it was aimed at a younger market. Grissom was assisted by Jacab Hay (1920-1976) as ghost writer. Hay subsequently co-authored the 1969 space thriller *Autopsy For A Cosmonaut* with John M. Keshishhian (b. 1923), in which a fictitious Gemini mission (Gemini 12A) is launched to investigate a fatal Voskhod mission.

4. Lyndon B. Johnson, 36th President of the United States 1963-1969, Item #121, Statement by the President on the Flight of Gemini 3, March 23, 1965, the American Presidency Project, http://www.presidency@ucsb.edu, last accessed August 7, 2017.
5. *Astronautics and Aeronautics*, 1965, entry for March 23, pp. 146-147.
6. **Gemini!** Virgil I. 'Gus' Grissom, Macmillan, 1968, p. 114.
7. **Forever Young: A Life of Adventure in Air and Space**, John W. Young with James R. Hansen, University Press of Florida, 2012, p. 83.
8. Gemini 3 Mission Report, pp. 7-33.
9. **Gus Grissom: The Lost Astronaut,** Ray E. Boomhower, Indiana Historical Society, 2004, re-printed 2011, p. 268.
10. Post-Flight News Conference, Gemini 3, Flight Fact Sheet 291-A, April 1965
11. New York Times, March 25, 1965.
12. *Astronauts Describe Flight at GT-3 Press Conference*, MSC Roundup April 2, 1965, Volume 4, No. 12, pp. 1-5 and 8-10.
13. Lyndon B. Johnson, 36th President of the United States 1963-1969. Item #134, Remarks at the Presentation of the NASA Awards, March 26, 1965, Lyndon B. Johnson papers, The American Presidency Project. http://www.presidency.ucsb.edu, last accessed August 7, 2017.
14. *Million Greet Two Space Heroes*, Robert Wiedrich, Chicago Tribune, p.1, p.3 and picture on back page.
15. New York Times, April 2, 1965, p. 12.
16. Gemini 6 crew releases.
17. *Astronautics and Aeronautics*, 1965, NASA SP-4006, p. 186 – entry for April 15.
18. New York Times, April 21, 1965, p. 11.
19. Gemini 3 Flight Fact Sheet, 291-A, April 1965.
20. Orlando Sentinel, April 24, 1965, p. 9.
21. *Astronaut Young Honored, 10,000 Cheer for Home-Town Hero*, Houston Post, Sunday April 25, 1965, p. 8.
22. Washington Post, May 4, 1965.
23. *Astronautics and Aeronautics*, 1965, p. 214, entry for May 3.
24. NASA News Release, MSC-65-166, May 19, 1965.
25. Indianapolis Star, May 21, 1965.
26. **Starfall**, Betty Grissom and Henry Still, Crowell, 1974, p. 157.
27. *Wives of two astronauts are modest*, Louise Hutchinson, Chicago Tribune, March 31, 1965, Section 1, p. 3.
28. Knoxville News Sentinel, June 3, 1965.
29. *Flags in Space: NASA Symbols and Flags in the U.S. Manned Space Program*, by Anne M. Platoff, in The Flag Bulletin: The International Journal of Vexillology, Volume XLVI (5-6) September-December 2007 #230 pp. 182-183
30. http://escholarship.org/uc/item/1tt282fs, last accessed November 14, 2017.
31. *Schirra, Young are Promoted*, Houston Post, Wednesday June 23, 1965.
32. *Remarks in Houston at the Manned Spacecraft Center*, Lyndon B. Johnson, June 11, 1965, The American President Project, John T. Wolley and Gerhard Peters, http://www.presidency.ucsb.edu/ws/?pid=27031, last accessed November 15, 2017.
33. Reference 26, pp. 158-159.
34. Reference 6, p. 116.

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Gemini fully operational

"It was a truly excellent engineering test flight of the vehicle."
John Young, *Forever Young* (2012).

With the two unmanned and the inaugural manned test flights now completed, the headline article in the first MSC Roundup following the Gemini 3 mission claimed, "*Gemini Program [is now] fully operational.*" [1] However, there remained an outstanding internal issue at Mission Control that needed to be cleared up first.

THE ETHOS OF MISSION CONTROL

A short time after the flight, a mission debriefing was held in the Building 2 auditorium at MSC. It was attended by members of the program office and the engineering directorate, as well as the flight controllers and the astronauts. The briefing focused on a very detailed walk through of pre-launch and flight operations, event by event, which resulted in a list of open issues for the next mission. At the end of this briefing, Gene Krantz asked all the flight controllers to remain behind. When the others had left, the doors were locked and Kranz addressed the group of controllers. He did not pull any punches, insisting that discipline had to be ingrained into their work ethic. "Controllers require judgment, cool heads, and they must lead their teams," he explained, noting that these characteristics were lacking in the team at the Carnarvon station in Australia. Kranz said that he understood the tensions, but at the same time he expected a degree of control. "We are the last line of defense for our crew," he told them, "We let a small incident escalate into a major flap that involved the entire operation. It was a distraction that we should have put behind us. We lost track of our objective." [2]

One consequence of the events in Australia was that they actually helped to define the role of a flight controller. Between them, Kraft and Slayton established a new protocol, in which the flight crew had control of the spacecraft while the ground team retained command of the mission, with crew safety always a priority. Overall responsibility for each

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9_10

mission firmly rested with Mission Control, the Flight Directors and the controller Capcoms at the remote sites. From Gemini 4, with the establishment of the new Mission Control at MSC, astronauts would work in shifts throughout the mission at the Capcom console there, representing the flight crew and Astronaut Office in each Flight Control team. Three astronauts were sent to remote tracking sites during Gemini 4, but only as observers. As for Dan Hunter, Kraft wrote that he transferred to NASA Goddard in Maryland after Gemini 3 and later served as the tracking station manager for NASA in Madrid, Spain during the Apollo missions.

At the end of the briefing in the MSC auditorium, Kranz closed the meeting with words that would become etched into the ethos of NASA Mission Control. He said, "Our mission will always come first. Nothing must get between our mission and us… *nothing!* Discipline is the mark of a great controller. That is all!"

The now-vacant Gemini Mission Control Center, Cape Kennedy, which was replaced by the new facility in Houston. It would become a popular tourist stop during a KSC Visitor Tour for 30 years.

ADVENTURERS OF OUR AGE

In the immediate aftermath of the flight of *Molly Brown*, the media quite naturally praised the success of the first American astronauts in orbit for 22 months. [3] During that time, however, the Soviets had completed four manned spaceflights: the solo space endurance record of five days with Valeri Bykovsky on Vostok 5; the dual flight of Vostok 5 with Vostok 6, carrying Valentina Tereshkova, the first female space explorer; the first 'crew' in space with the three Voskhod 1 cosmonauts Vladimir Komarov, Konstantin Feoktistov and Boris Yegorov; and, just a week before Gemini 3 flew, the world's first EVA, by Alexei Leonov from Voskhod 2, controlled by his commander Pavel Belayev.

The editorial in the Baltimore Sun on March 24 noted, "Yesterday's Gemini flight is described as 'historic' and so it was," before going on to state that each successful flight into space, launched from "whatever country, manned or unmanned," allows a body of knowledge to be amassed through increasingly sophisticated exercises by the "adventurers of our age, the astronauts."

There was, however, a more cautious note in the editorial of the Washington Evening Star (March 24), which suggested that the Russians seemed to be "well ahead" of America following Leonov's spacewalk. However, the article also remarked on the contrast between the openness of the American program and the closed, secret nature of the Soviet one, which cast an air of suspicion over some of the claims made by the Soviet program. But the paper did add: "In any case, regardless of what the Russians are hiding, there can be no doubt that the Grissom-Young flight represented an important advance for the United States in the race to the Moon." Prophesying the future, the Washington paper claimed that America was technically ahead of the Soviets in many respects, adding, "It is entirely possible that we'll make lunar landings before them."

In the New York Herald Tribune (March 24), further editorial reference was made to the perceived "race for the Moon," commenting that after Voskhod 2 and Gemini 3, "the Moon remains an elusive target, but [is] getting closer all the time." The editorial suggested that in an ideal world, this 'race' would have been a cooperative venture by all nations to embark on a global effort to explore the Moon, but it recognized that the fundamental technical, military, political and ideological differences of the time inevitably meant that this would remain a two-horse race. While future Soviet intentions in space remained unclear, the intended manned Gemini flight every three months "promises a vigorous effort on behalf of the Americans," with the Gemini 3 flight having carried America a long way forward along that path. "More importantly in the long perspective of history, it had brought closer the day when man, not American man or Soviet man, finally breaks the terrestrial bonds that hold him to his native planet."

According to the New York Times (March 24), the three-orbit mission by Grissom and Young in *Molly Brown* was "in some ways the most remarkable space trip yet accomplished by this country's astronauts." The most significant event was the successful series of maneuvers to change the orbit of Gemini, with the article noting the importance of such skills and their application for joining two spacecraft in orbit and in projected flights to the Moon.

Bold claims indeed, but what had Gemini 3 actually achieved in its flight of less than six hours?

During post-flight debriefing, Grissom (left) and Young examine in detail some of the negatives of photographs taken on their three-orbit flight.

MISSION OPERATIONS REPORT

On March 31, 1966, NASA released the Gemini 3 Mission Operations Report (M-913-65-03). The initial Gemini Program Mission Report had been released in April 1965 (MSC-G-R-65-2) and was refined and updated with amendments over the next few weeks, leading to the final edition. The document stated that the mission of Gemini 3 was, in essence, "to demonstrate the capability of the spacecraft to successfully accommodate the two astronauts in a three-orbit mission."

In summary, the report stated that following a review of flight results, "the performance of the spacecraft, launch vehicle, flight crew and mission support was satisfactory for the Gemini 3 mission. All primary and secondary mission objectives were met, two of the three experiments were accomplished and there were no serious flight problems encountered during the mission."

Conclusions

From launch to splashdown, the data gathered during the mission led to a number of specific conclusions, which were, briefly:

- The Titan II launch vehicle flew a higher than programmed trajectory, a phenomenon recorded on the previous flight. In this case, it was due to a higher than predicted engine thrust, as the engineers learned how the Gemini-Titan II combination performed for real as opposed to test data and wind tunnel predictions.

- The left-yaw drift, which was experienced during, "the first 44 minutes of flight," was found to be caused by venting of the launch-cooling heat exchanger (water boiler), resulting in unplanned thrusting.
- In the 90 seconds prior to the cut-off of the launch vehicle's second stage, a series of Inertial Guidance System (IGS) faults accumulated into velocity errors. Though these were greater than expected, they were not large enough to prevent switching over to the backup system to achieve a safe orbit at any time during ascent.
- Within 45 seconds of detecting this failure, the crew had analyzed the primary dc-to-dc converter and switched to the secondary converter. This restored the proper operation of instruments on the control panels in the spacecraft. This clearly demonstrated their appropriate training in both nominal and off-nominal situations and the correct management of systems on board the spacecraft.
- One potentially serious problem discovered on Gemini 3, with direct application to longer flights and rendezvous missions, was the large number of "loss of track" indications the horizon sensor system exhibited when Gemini 3 was within the intended operating attitudes to use that instrument. Though not a concern for the flight of *Molly Brown*, this would pose a problem if it was not resolved before the longer and more complicated missions were flown.
- During the mission, Grissom and Young observed a 'roll drift' on the Attitude Display Group (ADG). However, post-flight analysis of the results had indicated that the cause of this drift was due to its incomplete alignment during the platform alignment procedure.
- A constant in the computer, which was known to be wrong, caused a relatively small erroneous count-up to the increment velocity indications. This equated to about 1 foot/second per minute of computing time and would normally have been nulled out to zero, but in this case it was not.
- Grissom was unable to gather blood pressure measurements due to the late changes in the equipment and lack of familiarity with the new design during training.
- The balance between the heat transfer into the vessel and the low oxygen usage rate was the cause of the operation of the primary oxygen system at 1000 psia (68.9 bar) instead of the planned 800 to 900 psia (55.1 to 62.0 bar).
- The astronauts' operational equipment required some minor improvements. It was also noted that more emphasis should be placed on training the crew in these areas for future missions.
- Both Grissom and Young were mildly dehydrated after the mission, as recorded by their slight loss of weight, minimal hemoconcentration (decrease in the fluid content of the blood) and subjective thirst. It was suggested that this could have been caused by the redistribution of body fluids under weightless conditions, the loss of fluid after landing and insufficient intake of fluids during the mission, or even a combination of all three.
- Discomfort ensued if the spacesuit was left on for more than 15 to 20 minutes after landing.

- HF voice and direction-finding communications were not established, despite several attempts after landing.
- From the strength record of the Tel II antenna, tracking indicated that the signal strength was erratic.
- The actual angle of attack of *Molly Brown* during re-entry was considerably less than predicted from data obtained pre-flight in wind tunnel tests. A consequence of the reduced lift capability on this spacecraft during re-entry was that the actual landing point of Gemini 3 was short of that planned. As one of Gemini's primary objectives, this was a little disappointing, but while a pinpoint landing was not achieved, analysis of the data after the mission indicated that the guidance and control systems had performed as expected and that if the angle of attack had been more accurate, the systems would probably have controlled the vehicle to the intended landing point and certainly within the expected accuracy.
- The forces exerted on the flight crew when the parachute system changed from single-point to two-point suspension were in excess of those anticipated by the astronauts.
- The re-entry trajectory flown by *Molly Brown* proved to be "too mild" from a heating perspective to support a critical evaluation of either the heat shield or the protection of the spacecraft. However, after comparing the data with the Gemini 2 spacecraft, there was sufficient evidence to support the conclusion that the Gemini heat shield did provide adequate protection, even for the most severe re-entry planned for any of the forthcoming missions. This would remain an open issue until a correct entry had been flown.
- A faulty switch was found to be the cause of a failure which prevented the initiation of a pair of redundant cartridges that should have operated the forward compartment fresh air door.
- The crew compartment was found to be acceptable, except for a few minor discrepancies that were recommended for amendment as soon as the schedule permitted.

Reasons why

The trigger for the problem of yaw axis drift that troubled Grissom for so long was found to be a faulty header seal that allowed fluorine to escape and air to be drawn into the gyro. When Grissom changed acceleration direction relative to the gyro, the trapped air bubbles caused torques that resulted in transient drift. This was considered to be an isolated problem and did not require a redesign, though tilt tests were incorporated into the McDonnell testing facilities at the Cape to ensure that if this problem did reoccur, it would be detected prior to flight. It did not.

During the ascent of Gemini 3, errors in the Inertial Guidance System were evident when compared to the tracking data. Post-flight failure analysis revealed that this was due to "scale factor and bias instability in the X-accelerometer loop." There was also instability in an interim modification to this loop. On Gemini 2, an error of 66.5 ft./sec (20.27 m/sec) had been recorded in the X-axis when the second engine cut off. This was traced to an out-of-tolerance downrange error and suggested that there were erroneous accelerometer signals near to the BECO and SECO segments of the ascent phase. Later tests confirmed that these errors had been caused by saturation effects within the rebalance loop. After that flight, the rate network was redesigned to allow it to accept saturated inputs, but this change was made only to the 'X' loop in the IGS on Gemini 3. From Gemini 4 onwards, all the accelerometer loops in each axis incorporated the redesign.

The horizon sensor issue recurred many times during the course of the mission, but it was still able to align the platform and provide horizon scan mode control without any difficulty. Data analysed after the mission revealed that *Molly Brown*'s horizon sensor lost track a total of 382 times, for a cumulative 6 minutes and 6.1 seconds out of a total time of 4 hours 28 minutes 3 seconds from initial lock-on to when it was turned off. Further evaluation revealed that 291 losses of track (totalling 4 minutes 53.7 seconds) were the result of excessive spacecraft attitude movements as switches occurred between sensors, sunset and sunrise. Studies to discover whether clouds and special thruster firings were contributing to the loss of track were inconclusive. However, other testing conducted after the flight revealed that the horizon sensor system would lose track if the sun was within the azimuth coverage of the sensor and was located between the Earth horizon and about ten degrees above the horizon. To help isolate the problem for Gemini 4, special parameters were proposed for the horizon sensor system.

On spacecraft 3 and subsequently on spacecraft 4, the electrical switch to activate O_2 High Rate was on the sequential panel. It had already been determined by tests that it was not a sequential requirement, but this could not be changed prior to Spacecraft 5. Suit fan positions were changed to run both fans at the same time for greater circulation. A manual O_2 High Rate pull ring that was located on the central pedestal between the seats remained in that position throughout the ten manned missions in the series. The suit fan positions changed from No. 1 or No. 2, to No. 1 or No. 1 and 2 together, to enable the astronauts to run both fans simultaneously from spacecraft 4 onwards in order to get greater circulation in the latter position.

The review of the crew's performance during the mission made it clear that all of the crew-related mission objectives had been met and that their performance was satisfactory in the new vehicle. With two astronauts on board, it was now possible to operate the computer and control systems in parallel with manual attitude and control, to maneuver the spacecraft and complete the programmed suite of experiments. Having the two astronauts onboard working in unison enabled a far greater number of system evaluations to be conducted at any one time than had been achieved by the one-man Mercury flights.

The astronauts also demonstrated that Gemini could easily be maneuvered and proved the capability of the OAMS system. In addition, despite the short duration of the mission, evaluations of various subsystems during the flight were still achieved, including the Environmental Control System (ECS), the pressure suits, Guidance and Control (G&C), communications and the food and waste management, as well as the crew stations, controls and displays and the general habitability of the spacecraft. As the official reports indicated, however, "some problems did occur in these systems," but despite this, "valuable information was obtained on required fixes and, in general, the systems were adequate."

It was noted that pilot Young had experienced "considerable difficulty" with his stowed equipment, but that all the equipment had been evaluated and sufficient information gathered to be able to assess the problems and improve the equipment. The imagery taken by Young with the 70-mm camera was judged to be of excellent quality. As for the onboard experiments, while the crew was able to operate all the equipment, the objectives were only met on two of the three experiments.

In the post-flight evaluation of the mission, the analysis of data gathered from the Gemini mission, as well as the reports by the flight crew and the data assimilated during the unmanned flights of Gemini 1 and Gemini 2, led to the conclusion that "the Gemini spacecraft is suitable for manned space flight of extended duration."

The testing phase of Gemini was over, but there were a number of recommendations to take forward from the first manned flight, which would greatly improve the operational and procedural aspects of the program and the remaining nine flights. In fact, there were 21 separate recommendations listed:

- Suitable corrective action should be implemented to ensure the correct operation of the spacecraft's Inertial Measurement Unit (IMU). It was also suggested that further analysis and testing should be conducted on the IMU flown on Gemini 3 to understand exactly the excessive velocity error prior to SECO.
- Further tests and analysis should also be conducted on the horizon scanner systems to discover why the unit suffered a number of unlocks and to provide corrective actions, hopefully in time for Gemini 4.
- Amendments to the procedures for inertial platform alignment should include the ability to maintain the alignment attitude for a minimum of eight minutes (480 seconds). Following this, the pitch and roll attitude should appear aligned on the horizontal within one degree, for initial offsets no greater than five degrees in pitch, ten degrees in yaw and ten degrees in roll. Following Gemini 3's experiences, it was recommended that the minimum time should be increased to ten minutes (600 seconds) if the offsets were as large as five degrees in pitch, ten degrees in yaw and 20 degrees in roll. It was further suggested that a check of the alignment should be made after 90 degrees of orbital flight.
- Until more data could be gained from a subsequent mission (hopefully Gemini 4), the lift-to-drag ratio associated with Gemini 3 should be used to calculate orbital re-entry trajectories.
- The factors contributing to the landing footprint size and shift should be reviewed. Ensuring an adequate footprint on future flights might require tolerance reductions in order to calculate the size of the footprint and the procedure to determine it more accurately, as the tolerances for measuring and applying the velocity impulses appeared too large.
- To eliminate the torqueing moment on the spacecraft, the venting port of the launch-cooling heat exchanger should be amended.
- A further study should be made of the HF communications systems, including all effects known, to determine whether such a system could provide long distance communications. It was suggested that a special test of the ground network should be performed in support of this effort, prior to Gemini 4, with the aim of determining the adequacy of receiving and recording capabilities. It was also suggested that standardization should be applied to the readiness procedures and operational checks and methods, as well as to post-flight reporting. In addition, there should be a review of pre-flight test procedures for the checkout of the spacecraft's HF system, including the antenna. It was also recommended that such tests should be

sufficient to establish the flight readiness of the system as close to launch as possible.

- The flight crew or ground command should turn on the real-time telemetry transmitter at least 20 seconds prior to the start of tape playback through the delayed time transmitter, to avoid unnecessary data losses.
- Despite the lack of significant data from Gemini 3, it was recommended that an analysis should be made to determine the feasibility of reducing the thickness of the spacecraft's heat shield, without affecting its structural integrity or crew safety. This would yield a weight (mass) saving which could prove useful on the subsequent longer missions.
- A test program should be conducted to define and evaluate the forces imparted on the flight crew during the change from single-point to two-point parachute landing attitude. The results of this program should provide the information required to make or indicate any modifications to flight crew procedures that may be necessary for future [Gemini] flights using this system (a process which would also apply to the USAF MOL/Gemini program).
- With regard to the crew compartment on Gemini 4, there were two issues for which it was recommended that corrections should be implemented prior to that mission:

  a) The failure of the flight plan roller display to provide advance information of upcoming flight events.
  b) The need for interim stowage of bits and pieces of waste, such as food packaging and clipped off ends, used note paper, used towels and other detritus.

- In addition, the following issues should be corrected as soon as the schedule permitted. These were also related to the crew compartment, but would not be implemented until after Gemini 4:

  a) Inadequate lighting of the flight plan roller
  b) Poor readability of the GMT clock
  c) Lack of visual or aural warning for loss of cabin pressure
  d) Poor visibility of the cabin pressure gauge
  e) Marking of the spacesuit visors by the underside of the hatches.

- There should be greater emphasis placed on the locations of stowage and the development of procedures for handling loose equipment.
- Prior to the planned four-day Gemini 4 mission, it was recommended that the incompatibility between the spacesuit structural zipper tab and the urine disposal equipment should be prioritized.
- With reference to the food evaluation on *Molly Brown*, it was recommended that the following problems should be addressed prior to Gemini 4:

  a) When used, rehydrated juice containers were folded for stowage, there was a tendency for the liquid to seep from the ends of the containers and float about the cabin.
  b) The loss of a germicide pill was caused by the difficulty in heat-sealing the food container joints sufficiently.

- Recommendations for corrections to the waste management system were also put forward for resolution prior to flying Gemini 4:
  a) There was an inadequate method of stowing and disposing of the paper associated with the defecation device.
  b) Difficulty was experienced in breaking the disinfectant bag within the defecation device.
- It was suggested that for subsequent missions, the following recommendations should be adopted:
  a) Call outs for the crew to take on water at regular intervals should be part of the flight plan. As all future missions would last longer than a single day, it was recommended that regular reports of water consumption should be made to the aeromedical flight controllers.
  b) Unless the touchdown point was within 20 minutes of the recovery ship, the crews, upon landing, should remove their spacesuits immediately after the determination of a safe condition of their spacecraft in the water.
  c) Reports of glare effects from rocket plumes on the eyes of the crew should be taken into account when planning retrograde maneuvers on future flights, in relation to eye adaptation and horizon visibility.
- Exercises in the Gemini Mission Simulator should be upgraded to include more realistic problems, including an error of velocity during the launch phase, an error of accelerometer bias during orbital maneuvers and variations in the lift-to-drag ratio of the spacecraft.
- Using the known bias from GT-2 and GT-3, the Titan II launch vehicle engine model should be updated.
- The resulting, higher than expected engine thrust encountered on GT-2 and GT-3 should lead to a correction of the launch vehicle pitch program.
- Finally, it was suggested that the Eastern Test Range (ETR) should instigate an investigation to determine the causes of the erratic tracking of the Tel II radar as recorded on both GT-2 and GT-3 and affect a fix.

EXPERIMENT RESULTS

As well as the engineering and technical objectives, the crew of Gemini 3 was also tasked to conduct three scientific experiments and obtain photographic coverage during their mission. In addition, there were aeromedical measures taken as part of an ongoing study of human response to spaceflight and to expand the database on such research. Only two of the three experiments were completed successfully. The third, the sea urchin egg growth experiment, could not be completed due to a mechanical failure in the equipment. The photography objective was only partially completed due to an incorrect lens on the 16-mm camera. [4]

70-mm Hasselblad Earth Photography

Though not specifically an 'experiment' on this flight, a 70-mm Hasselblad 500-C camera, with an 80-mm f/2.8 lens and loaded with 70-mm Ektachrome film, was flown to obtain images of the Earth's surface. In all, 25 frames were exposed during the mission, seven of which were considered usable for studies of the Earth's terrain. These covered the areas of northwest Sonora, the Rio Grande Valley and Bermuda. During the first orbit, a single image was taken which encompassed Mexico (Tamaulipas to Nuevo Leon), Texas, the Gulf of Mexico and Falcon Lake. During the second orbit, frames 2 and 3 were of the cloud cover over Bermuda in the Atlantic Ocean and frames 4 through 7 were of Mexico (Sonora to Baja, California) in the foreground with California and Arizona in the background. The majority of the images exposed, frames 8–25, were taken during the third and final orbit. Frames 8 through 15 were of the clouds over the south east African coast, frames 16–20 were taken over the southern end of the Malagasy Republic, also showing cloud cover. Frames 21 through 24 were of more clouds, this time over the Indian Ocean, while the final frame was of the limb sunset over the Indian Ocean.

16-mm, Thruster Plume Evaluation imagery

Though apparently operated successfully, the crew had not been given the proper lens settings for the planned low-light-level photography of thruster plume evaluation prior to the flight and thus the 16-mm photography was a complete failure.

Earth terrain photography was to figure prominently in the subsequent Gemini missions, establishing baseline data for further extensive studies in Earth orbit from Apollo spacecraft (and the Skylab orbital workshop), all of which pioneered the expanded Earth resources studies undertaken during the Shuttle program and which continue today in the era of space stations.

S-4 Zero-g and Radiation on Blood Cells

The objective of this experiment was to test the theory that radio-biological effects were associated with flights into space. Post-flight blood samples were obtained from the flight crew 6 hours 30 minutes after the launch, (1 hour 40 minutes after splashdown). All the samples had been put into culture 3 hours 30 minutes later; those from the ground control experiment at the launch site and those from the in-flight samples on the prime recovery vessel. The day after the launch, the crew's pre-flight cultures were fixed, about 72 hours after they were made. The experimental cultures, plus the post-flight cultures from the crew's blood samples, were all fixed by approximately 77 hours after launch. Upon completion of this phase, all the samples and experimental devices were returned to Oak Ridge National Laboratory for analysis. Post-flight examination revealed no signs of physical damage, nor were there signs of leakage or contamination. However, the corners of two of the blood-sample holders were broken after recovery, as the result of a minor accident on the recovery vessel.

A full analysis of the experiment is not possible here and readers are directed to the reference documents for further information. In summary, the post-flight report stated: "The S-4 experiment failed to demonstrate [any unexpected effects] from the small amount of ambient radiation encountered by the spacecraft during flight. No aberrations attributed to the flight were found in the blood samples from the crew. Further, the few aberrations seen in the flight control samples can readily be accounted for by the small radiation dose they received from radiation sources during the flight. However, analysis of both the ground and flight samples revealed that while there were no significant differences in the yields of multi-break aberrations, those from the flight were significantly higher in the single-break aberrations. The researchers used several lines of evidence to rule out the possibility that these 'out of normal' differences were the result of known factors. Further study of both pre- and post-flight samples from the flight crew indicated that a flight into space alone did not induce these changes. Preliminary results suggested that there was perhaps a connection between the use of certain drugs and human organs together with parameters of spaceflight and radiation." [5]

T-1 Re-entry Communications
Attenuation levels were measured both with and without water injection at UHF frequencies of 230.4 Mc and 296.8 Mc and in the C-band frequency of 5690 Mc. The UHF signals which had been blacked out were restored to significant levels by the high flow rate injection during the early portions of the water injection sequence. In the latter portion of the experiment, the C-band signal was also enhanced by the medium and high flow rate injections. The post-flight experiment summary stated that "while the experimental results verified that signal recovery from Gemini blackout can be achieved, much can be done to improve the technique. Future experiments are under consideration for Gemini and Apollo missions, which will utilize more ideal antenna locations and injection sites which are designed to minimize the problem of signal directionality. These experiments would result in more efficient use of water and could lead to operational systems to eliminate blackout on manned space flight."[1]

Sea Urchin Egg Experiment
This experiment failed due to a faulty activation handle.

Aeromedical studies
From the Mercury missions, it was found that similar flights of this duration (3 orbits) did not induce any significant physiological changes. The data from Gemini 3 gave further assurance that commitment to longer flights could be given, especially as the next few missions included plans to extend orbital duration to four, eight and fourteen days. The medical histories of both Grissom and Young since their selection to the astronaut program

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[1] This problem of communication with a spacecraft through the plasma layer as it enters the atmosphere was not addressed until the Tracking and Data Relay Satellite System (TDRSS) network was deployed by the Space Shuttle in the 1980s and 1990s. The shape of the orbiter helped to establish communications during entry. As the majority of heat was on the underside (belly) of the orbiter, with its thermo-protective tiles facing down and bearing the brunt of the ionizing plasma layer, that layer was 'open' at its trailing end behind the Shuttle, above the crew compartment, the closed payload bay and the upper wing surfaces. It was found that the signals could be sent directly through the 'gap' to TDRSS and then down to the ground and vice versa, without the need to penetrate the plasma layer. Even if TDRSS had been available for Mercury, Gemini or Apollo, however, their smaller, blunt-body cone shape would not have been sufficient to create a gap in the plasma as the Shuttle orbiter did.

were reviewed, together with data collected during a variety of tests and simulations in which they were required to wear biomedical instrumentation.

Both men felt well during the lead up to the launch, experiencing neither discomfort or tension for the task ahead. The noise, acceleration and vibrations experienced by the crew during ascent were not a problem and with the onset of 'weightlessness', neither astronaut reported any disorientation, nausea, vertigo, hunger, somnolence (drowsiness), or any untoward physiological or psychological reaction. Both men reported normal vision and color perception, with their ground sighting experiments limited only by cloud cover, not their vision. Food evaluation and waste evaluation objectives were mostly successful, but would require further refinement of training procedures and certain mechanical difficulties with equipment would need to be overcome. During the re-entry phase, the *g*-forces endured did not cause either man any difficulty, though the change from single- to two-point suspension did result in a sudden and violent forward motion that caused damage to their face plates but no injuries to the crewmembers. Finally, post-flight activities were essentially nominal in their readjustment back to Earth's gravity environment, although the lengthy period spent inside the cramped confines of the Gemini capsule on the water did induce periods of nausea and minor vomiting.

Generally, there was nothing to suggest from Gemini 3 that the program could not attempt a longer mission on the next flight, nor continue with plans to schedule a full 14-day mission in the Gemini spacecraft.

REVIEWING PARACHUTE SUSPENSION MODES

As the work continued on evaluating the results from the mission, there were a few issues to be addressed where equipment or systems did not perform as designed. One of the most significant of these was the unexpected force of the jolt endured by Grissom and Young during the change between single-point and two-point suspension under the parachute during the recovery of *Molly Brown*.

On May 13, tests were conducted at the McDonnell Aircraft Corporation's facilities in St. Louis, to try to replicate the effects of the change of the spacecraft's attitude experienced by Grissom and Young, when both men's helmets struck the windows. These tests were performed using the re-entry module of Gemini Static Article #4 and were completed at the company's Structures and Dynamics Laboratory. [6]

Gemini Static Article #4 had previously been modified to simulate flight weight and center of gravity by applying ballast. When the McDonnell engineer participated in the manned tests, the left (Command Pilot) ballasted seat was replaced with a production seat. The vehicle was suspended by a nylon rope, which acted both as a mechanical spring and a dampener to simulate the shroud lines of the main parachute canopy and the spring effect generated from that canopy. To start the inversion, a mechanical release was used in the single-point position. Using an 11-degree angle from the nominal single-point suspension attitude and a 120-foot loop of nylon rope, the accelerations of an actual flight inversion could be simulated. This proved suitable for the tests and compared favorably with similar boilerplate drop tests held previously at El Centro, California. For the safety of both the occupant and the Static Test Article, cables were attached to the RCS section and to the helicopter hoist loop fitting. In addition, a safety net was installed below the suspended vehicle.

A number of unmanned inversions were completed during the program, initially to demonstrate the repeatability of loads and accelerations and the structural integrity of the test set up. These were followed by four manned inversions; one each at 46 degrees and 26 degrees from the normal single-point suspension, then two at 11 degrees from the nominal single point position. Inside the Test Article, a TV camera monitored the head motions of the occupant and recorded the results on videotape for later evaluation. In addition, an external motion picture camera was used to record the motion of the vehicle in all the tests. Strain links recorded the loads in the inversion bridle of the parachute harness and accelerometers were installed in Static Article #4 to record the loads in the simulations. An additional accelerometer was used to monitor the occupant's helmet in all the manned inversion tests. During those tests, all the restraint harnesses were properly locked and at no point did the occupant strike the window.

Following the manned drops, the [unidentified] test engineer commented on the program. He felt that with correctly secured lap and shoulder harnesses, it would be extremely difficult to make contact with the window. It appeared that Grissom was riding extremely high in his seat and came forward out of it, pivoting at the waist. The test engineer surmised several factors for this: The astronaut's torso was longer than the test subject; Grissom had an egress kit pad that was thicker than that used by the test engineer (the new, cut down kit was used in the tests); Grissom's shoulder harness was not locked; and in addition "there is no way that the test could have simulated the parachute oscillations the GT-3 may have encountered or the natural dampening of the chute which may have made the test not as severe as the actual drop." A comment from Young was included in the report, in which he indicated that he did not think the test was severe enough.

As a result of these simulations, no changes to future spacecraft were proposed, but a number of recommendations were put forward:

- The astronaut flight crew should re-adjust their restraint harnesses following re-entry and while still under gravity loading.
- The crewmember should position themselves as low as possible in their seat following *g*-loading.
- Inversion should be made on the parachute upswing, if possible.
- Each astronaut should brace themselves by placing a hand against the window and should allow his head to come forward out of the headrest after the initial inversion has occurred.

One of the consequences of the astronauts damaging their helmets during the Gemini 3 landing phase was the change from a visor made of Plexiglass to a stronger Lexan polycarbonate design. The downside of this was that the newer visor could be scratched more easily, but these could easily be erased by polishing. [7]

Hopefully, these recommendations would ensure that the episode experienced by Grissom and Young would not happen again.

That sandwich again…

During the crew's post-flight press conference held in the Carriage House Motel at Cocoa Beach on March 25, the subject of the corned beef sandwich was raised by a reporter, who asked Young how he had slipped the sandwich aboard. Young laughed and asked, "How did you find out about that?" The reporter then asked if they could expect to read about the sandwich incident or the souvenirs carried onboard the spacecraft in a forthcoming issue of *Life* magazine. Grissom replied, "I don't think so."

The astronauts thought little more about it and neither did many others at the time, but predictably, once the press had gotten hold of the story, it seemed to take on a life of its own and, as the official NASA History of Gemini stated, "a storm later blew up." [8] The incident had upset the flight surgeons, who started complaining of breaking medical protocol and that it threatened their medical data (which it did not). Then the engineers warned about the threat from floating crumbs in the spacecraft, which might have floated behind the control panels and fouled up the electronics (which fortunately they had not). Naturally, the press, recognizing a 'great story', suggested that NASA had "lost control of its astronauts." This irritated the top brass and even members of Congress entered the affray.

Consequently, the stories and tales of the sandwich incident abounded over the years, much to the irritation of many directly involved. In just one account of the event, recounted in the 1994 book *Moonshot*, reportedly by Al Shepard and Deke Slayton in cooperation with space reporters Jay Barbree and Howard Benedict, John Young's sense of humor was not known to many people early in the program. The 'sandwich episode' started as a series of 'secrets tests', which were conducted on a number of corned beef sandwiches (reportedly a favorite of Grissom) at Wolfie's delicatessen in Cocoa Beach. Apparently, a sample from each batch of specially-prepared sandwiches was taken to the top of a tall ladder and then dropped in 'free-fall' to see which held together the best. The one which still resembled a sandwich presumably became the 'recipe' for the one which was then sealed and given to Wally Schirra (hopefully, not one of those which had ended up on the floor!). The 'secret experiment' was then refrigerated until it could be passed to Young on the day of launch, who quietly slipped it into one of the leg pockets in his spacesuit [9].

One of Young's tasks on the mission was to evaluate the food intended for longer flights, but officially there was no meal break for the crew. Knowing that Grissom was not enthusiastic about the space food and faced with a five-hour mission together, two or three hours between their breakfast and the launch and another hour or so from splashdown to recovery, Young reasonably assumed they would be feeling hungry.

Both Shepard and Slayton thought the furor was over very little, "just one lousy sandwich," but with the episode reported to the law makers, a Congressional House Committee on Appropriations was assembled. They incorrectly assumed that Young had ignored the food evaluation task, costing the country "millions of dollars," which of course was ludicrous, but something had to be done, or at least be seen to be done. What was not made clear, either to the press or to the congressmen and legislators, was that the official food evaluation was just that – an evaluation. However, this was not an evaluation of its biomedical properties, it was simply an experiment to evaluate the food's taste, convenience, and consistency. Neither Young nor Schirra had broken any rules and according to *Moonshot*, Schirra had actually informed Slayton of the intended sandwich prank before lift-off. Slayton thought it was a great way to alleviate some of the tension in the build up to the first mission. [10] Indeed, the astronauts had flown a near-perfect mission and had proven the design of the Gemini for longer flights, but these important achievements seemed to have been lost thanks to a relatively insignificant moment that was blown out of all proportion.

In Schirra's 1988 biography, he stated that this was not the first such incident. [11] On his own Mercury flight in 1962, Gordon Cooper had placed a 'special ration pack' in Sigma 7. This included a steak sandwich, a two-ounce bottle of Scotch and, as Schirra was a smoker, five cigarettes. Schirra's harness had prevented him from reaching the rations during the flight, but he did acknowledge that smoking and drinking on the flight were forbidden.

It simply had not occurred to the administrators of NASA that an astronaut would smuggle something on board, especially something as innocent as a sandwich. But the damage was done. Wolfie's delicatessen garnered a lot of free publicity, but something had to be done to settle the matter. As a result, Deke Slayton sent every astronaut a memo outlining the official line for any future mission: "The attempt… to bootleg any item on board not approved by me will result in appropriate disciplinary action. In addition to jeopardizing your personal careers, it must be recognized that seemingly insignificant items can have an effect on follow-on crews." This memo had its own knock-on effect for all personal items flown in both the astronaut's own 'Personal Preference Kit' and in the 'Official Souvenir Kit' on future missions, for many years to come. In a clear demonstration that NASA had not "lost control" of their astronauts and were in fact establishing new ground rules, the episode also rekindled the matter of naming each spacecraft. From the next flight, all subsequent 'solo' spacecraft would be referred to only by their mission number. [2]

The astronauts move on

Despite the uproar, the sandwich episode did not seem to affect the career of either man, as both were soon in training as backups to Schirra and Stafford for Gemini 6. After that mission, Grissom would move over to command the first Apollo crew, but tragically, fate would step in to prevent him and his fellow crewmembers fulfilling that plan. Meanwhile, Young remained with the Gemini program for the time being and would use his experience to take the Command Pilot seat on Gemini 10. He then went on to fly on two Apollo missions to the Moon (Apollo 10 and 16), including landing on the lunar surface on Apollo 16 to become the ninth man on the Moon. Young would later become Chief Astronaut between 1974 and 1987 and remained at NASA to command the first Shuttle flight (STS-1 in 1981) and the first Spacelab mission (STS-9 in 1983). Eager for a seventh mission, to which he had been selected (planned as STS-61J in 1986), he was thwarted by the cancellation of the mission in the wake of the *Challenger* tragedy in January 1986. All flights were

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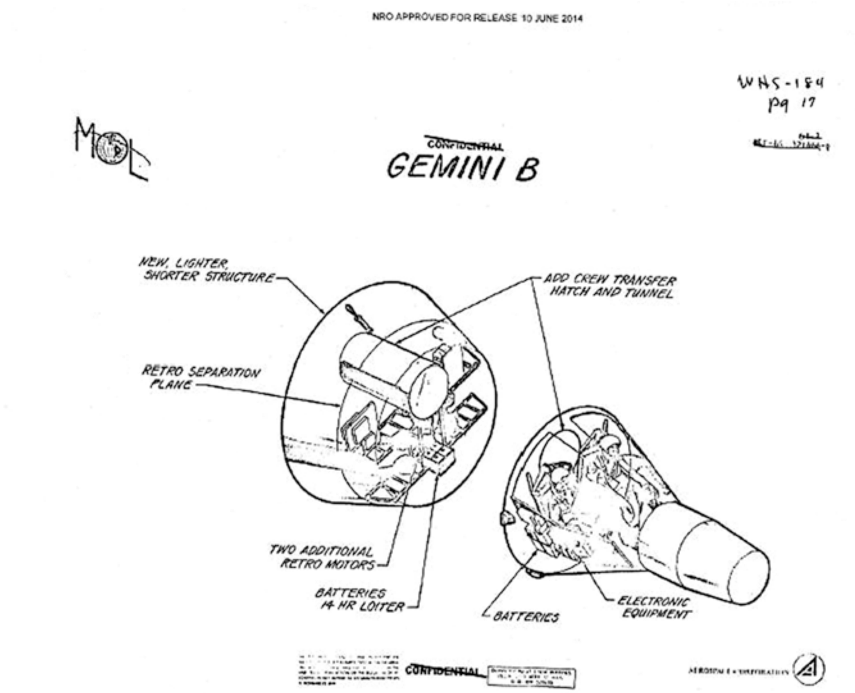
[2] The naming issue would become a problem again from Apollo 9 in March 1969, the first mission to involve two spacecraft flown separately, because the CSM and the LM required two different radio callsigns to identify them. Therefore, from that flight to the Apollo 17 mission, each Apollo CSM and LM was given its own, occasionally frivolous, callsign. This practice ceased again for Skylab and ASTP, only to be revived once more by the individual naming of each Shuttle orbiter.

suspended pending the inquiry and Return-to-Flight program and by the time flights resumed in 1988, Young had been replaced as Chief Astronaut (by Dan Brandenstein) and had moved to more managerial roles, although remarkably, he retained his active flight status. He finally hung up his spacesuit – probably reluctantly – in December 2004 at the age of 74, after 42 years as an astronaut, the last 17 of which were spent in managerial roles.

After he left the space program, Young penned his autobiography, in which he wrote: "My story of Gemini III would not be complete without some comment on the scandal surrounding the corned beef sandwich." [12] In his opinion, the whole thing was blown out of all proportion, adding that it was not even the first corned beef sandwich on a spaceflight but the third. Young wanted to make clear that it was an insignificant part of the mission that did not deserve the attention it got. Gemini had flown three orbits superbly, Grissom had put the spacecraft through its paces admirably and there were twelve systems to be evaluated on *Molly Brown*, every one of which checked out. According to Young, Gemini 3 was, "a truly excellent engineering test flight of the vehicle." The sandwich incident was a few seconds in a two-minute interval during a near-six-hour mission. Young closed the issue in his book by stating, "It didn't even have mustard on it. And no pickle." Despite all this, the sandwich unfortunately remains as one of the first things to be associated with the mission of Gemini 3, ahead of many of the mission's important accomplishments and notable achievements by the two astronauts.

Re-launch of Gemini 2 on November 3, 1966, as MOL-B became the only launch of that program.



A recently declassified (June 2014) drawing of the Gemini B configuration revealing the planned changes to be made to qualify the spacecraft to fly manned MOL missions, which of course it never did. These amendments included the transfer tunnel and hatch in the heat shield of the Re-entry Module, additional retro motors, batteries for up to 14 hours orbital loitering separated from the MOL laboratory and a shortened and lighter Adapter Module. (Courtesy USAF)

Gemini spacecraft 2 returns to space – briefly

On May 19, 1965, NASA announced that the recovered Gemini 2 Re-entry Module had been given new mission. Having completed its sub-orbital flight that January on top of a Titan, it was now going to be returned to McDonnell Aircraft Corporation for reworking before being delivered to the USAF in July 1966. Then, after preparations for a second suborbital flight, this time in the Gemini B configuration, it would be launched on a more powerful Titan III-C to test a new heat shield design. The Gemini B was intended for use in the USAF Manned Orbiting Laboratory program (MOL), serving as the two-person crew transport vehicle to orbit and back to Earth. To facilitate crew transfer to and from the orbital laboratory, a hatch was cut into the spacecraft's heat shield. On operational MOL missions, this would be connected to a transfer tunnel into the laboratory for classified missions of up to 30 days. [13]

On November 3, 1966, eight days before the final NASA Gemini (number 12) left the pad, the former Gemini 2, the second vehicle to fly, now became the penultimate 'Gemini' launch, as the Titan III-C blasted off from LC-40 at the Eastern Test Range (Cape Kennedy). The combination performed a flawless ascent. This launch was the sixth in a planned series of 12 designed to qualify the composite Titan III-C for operational service and was cited by USAF officials as a “major step in the MOL program.” This time, the Gemini capsule was designated as MOL-B and was adorned with the military markings of the USAF, including a white star insignia which it had not carried on its original mission for NASA. In its previous role as Gemini 2, the spacecraft had been filled with weights and test equipment to simulate the two-man crew and it would also be highly instrumented for this second flight. The trans-stage restarted twice to achieve the planned orbit of 190 miles by 185 miles (305 km by 298 km), inclined at 32.82 degrees, before the 38-ft. experimental MOL canister, designated OPS 0855, was released. This achieved one of the mission’s objectives, proving the Titan III-C’s capability of boosting such a long payload into orbit. The canister was given the orbital designation of OV4-3 (1966-099A).

The second objective on this flight was another evaluation of the Gemini spacecraft’s heat shield, this time with its new hatch design. The RF-300 insulation used on the NASA Gemini vehicles was omitted as it was expected that the re-entry of the MOL-B Gemini would not be as severe. Indeed, the Gemini heat shield design limit of 430 degrees F (221.1 degrees C) was far higher than was recorded on the MOL-B Gemini, which reached only 133 degrees F (56.1 degrees C). [14]

There were concerns over whether hot gases might penetrate the seal around the hatch during re-entry, potentially leading to the destruction of the vehicle. However, the test was successful and finally confirmed that the design chosen for MOL’s Gemini craft was structurally secure.

[Main image] In 2007, former MOL and NASA astronaut Robert L. Crippen was photographed near the MOL-B capsule 41 years after it flew its second mission. This image shows the heat-shield hatch through which the MOL astronauts were to access the MOL laboratory module. (Courtesy NASA) [Inset] The recovered Gemini 2/MOL-B on display at the Air Force Cape Canaveral Air Station Museum, Florida. (Courtesy USAF)

The MOL laboratory was a mockup, fabricated from a Titan propellant tank bolted to a trans-stage. It included a number of research payloads, which together were designated 'Manifold'. The plan was to operate the research equipment for 75 days, twice as long as the planned MOL missions, but the spacecraft ceased operations after only 30 days, with its last contact being made on December 3, 1966. It re-entered Earth's atmosphere on January 9, 1967 and was the only item of MOL hardware to fly in the program. The Manifold experiment package consisted of:

- Two micrometeoroid detection payloads.
- ORBIS-Low transmitter beacon.
- Five experiments, including investigations into cell growth, thermal control, light reflection in space and heat transfer, plus a fluid dynamics experiment designed to monitor propellant transfer in zero-g.
- Prototype hydrogen fuel cell and attitude control system.
- Three additional satellites in the adapter connecting the Gemini to the MOL mockup, which were released in low Earth orbit after the Gemini was separated. These were the OV4-1R and OV4-1T comsats and the satellite OV-VI.
- The exterior of the OPS 0855 being painted so that the spacecraft could be used as a target for *ground-based* optical tracking and observation experiments, something of an irony for a program intended to be a base for *orbital* observations and tracking experiments.

The Gemini B Re-entry Module (minus the Adapter Module) was released on its sub-orbital trajectory at an altitude of 125 miles (201 km), traveling at 17,500 mph (28,163 kph). The spacecraft completed a highly successful 5,500-mile (8,851 km) trajectory, re-entry and parachute descent into the South Atlantic, landing just seven miles off target, after a flight of just 33 minutes. Recovery of the spacecraft was completed by the USS *La Salle* and following post-flight evaluations, it was subsequently put on display at the Air Force Space and Missile Museum at the Cape Canaveral Air Force Station, Florida.

With the escalating cost of the Vietnam War consuming a significant percentage of the Defense budget, coupled with the projected rise in the cost of MOL from $1.5 to $3 billion and the frequent delays to the first of a planned seven MOL missions (five manned and two unmanned), the program was finally cancelled on June 10, 1969. The delays were a significant contribution to the program's demise, as unmanned reconnaissance satellite technologies were developing to the point that they were expected to meet or even exceed the capabilities of the MOL program. Many inside the program were still amazed that it was cancelled, however, considering all the hard work and money that had gone into getting the hardware and payloads defined and ready for flight. It was a sad end to a program that had outlived its usefulness before it could prove itself. One positive outcome came from the re-flight of Gemini 2, which proved that an adequately fabricated and protected spacecraft could indeed make more than one flight into space (underscoring the results from the series of thirteen astro-flights to the fringes of space between 1962 and 1968 in the X-15 program). Its application was demonstrated fifteen years later, with the first two missions of the NASA Space Shuttle flown by the same orbiter (*Columbia*).

The Fate of *Molly Brown*

The Gemini 3 re-entry capsule '*Molly Brown*' was later relocated to the National Air and Space Museum in 1970, apparently after completing undefined tests in support of the MOL program. In 1983, it was reported that *Molly Brown* was on loan to the Department of Natural resources in Indianapolis. Subsequently, the spacecraft has been on display (together with Grissom's Gemini spacesuit) at the Gus Grissom Memorial at Spring Mill State Park, two miles east of the astronaut's hometown of Mitchell, Indiana. [15] There has also recently been a full-size replica of '*Molly Brown*' on display at the USS *Intrepid* Sea, Air and Space Museum, Pier 86, New York City, alongside Scott Carpenter's *Aurora-7* Mercury capsule. Both spacecraft were retrieved from the ocean by the USS *Intrepid*.

SUMMARIZING THE GEMINI TEST FLIGHTS

At the beginning of the program, the six objectives for Gemini had been stated simply as:

- Exposing two astronauts and their life support systems to long-duration spaceflight for projected future Earth orbit and lunar missions
- Developing and evaluating precision re-entry, landing and recovery of a manned spacecraft
- Rendezvous and docking with a second orbiting vehicle and then performing maneuvers
- Evaluating the ability to perform useful tasks during extra-vehicular activity
- Utilizing the Gemini spacecraft as an experimental test-bed for a range of scientific and technical experiments and investigations, and
- Providing a continuation of manned spaceflight operations (after Project Mercury and prior to Project Apollo) at minimum cost, with major milestones to be completed in the shortest (but safest) possible time.

Following the occasionally challenging development of the program, management, hardware and infrastructure between 1961 and 1965, the flight test program conducted by the first three Gemini missions provided the first steps towards addressing several of the main objectives, but also identified issues that still needed to be resolved before complete success could be claimed. All three missions had their challenges – sometimes technical or man-made and at times affected by the forces of nature – but overall it was a good start.

The flight of Gemini 3 had "exposed two astronauts and their life support systems" to a relatively short mission and, despite some early teething problems, the life support systems worked quite well. Both Gemini 2 and 3 proved that the program's ocean landing profile worked well and safely and while they were a little off target, the reasons why were soon identified. While the surprise and unexpected results of changing from single- to two-point suspension were recorded only on Gemini 3 in the whole program, that did at least vindicate conducting a manned test of the whole system prior to operational missions. There was a brief attempt to get a sighting of the second stage of Gemini 3's launch vehicle during the mission, but this could not be executed as the Gemini was facing the wrong way during the small window of opportunity. However, the mission did include the historical achievement of becoming the first spacecraft to maneuver in orbit, a vital step in the preparation for the more complex rendezvous and docking missions later in the program. While the mission did not include an EVA, the crew of Gemini 3 did perform an altitude test during the training and discovered the difficulty of closing the hatch at the end of the exercise, which was important information for Gemini 4 EVA planning. Gemini 3 also carried three small scientific experiments, while both Gemini 1 and 2, together with Gemini 3, were engineering evaluations in their own right, utilizing dozens of recorders and sensors to provide data on the countless systems, procedures and operations that could be incorporated into the preparations and upgrades for follow-on missions. Finally, there was the procedural flow from Mercury that ran through Gemini and subsequently on to Apollo: of mission preparation, building the hardware, training the crew, launching the flight, controlling the missions, fulfilling the flight plan, recovering crew and spacecraft and then evaluating the results to feed back into the system for the next mission just weeks away.

Gemini 1, 2 and 3 were vital to the success of Gemini 4 through 12 and, in part, for the confidence to prepare for Apollo. What was planned for Gemini in order to gather the information and experience required to fly Apollo with confidence was given a huge boost with the overall success of the three test flights. In addition, not only had a new space vehicle been tested and proven in such a short timescale with relatively few flights, but so, too, had a new launch vehicle for manned space flight and the operations required to bring all the elements together. Gemini 1 and 2 together provided the evidence that the Gemini design and system could be safe enough to fly a crew on only its third mission. The flights of Gemini 1 and 2, though short in nature, proved that Gemini could indeed fly safely on Titan, that the spacecraft could function efficiently in orbit and that the heat shield and parachute recovery equipment was an effective landing system. Then, Gemini 3 proved that this commitment was justified and allowed progress beyond the test program to the operational flights, starting with Gemini 4, although it must be stated that, just four years into the saga of human spaceflight in Earth orbit, *every* mission at this time was essentially a new 'test-flight'. Gemini was not, in its original form, ever intended as a fully operational system, though there were plans and long lost dreams which hoped that one day it might be.

All the primary and secondary mission objectives for Gemini 1 were attained and all the primary objectives for Gemini 2 were met, apart from performance tests on the fuel cell which was flown as a separately-loaded power source for engineering evaluation rather than as a power source for the spacecraft. There were two minor anomalies encountered during Gemini 2. The first was the higher than predicted temperatures recorded near the adapter interconnect fairing. This required corrective action for Spacecraft 3, in that the thickness of the shingles in this area was increased and the designed angle of attack for re-entry was reduced, which changed the center of gravity slightly. The second was an error in the IMU accelerometer output (Inertial Guidance System) of about 66.5 ft./sec (20.02 m/sec) in the X axis, which required a redesign for Spacecraft 4 onwards and a change in the X-loop only for Gemini 3.

By May 1965, the Gemini log book had recorded three launches (one of them manned) with two planned recoveries, totaling an unmanned official flight time of 5 hours 8 minutes

16 seconds and 3 orbits (Gemini 1 completed a total of 64 orbits prior to entry four days after launch). The total manned flight time was 4 hours 52 minutes 31 seconds and 3 orbits, but much more would soon follow.

THE LEGACY OF GEMINI 3

Receiving the command of a brand new spacecraft (as Gus Grissom did not once but twice, counting Apollo 1), becoming the first man to fly in space twice and becoming the first astronaut to manoeuver his spacecraft in orbit says a lot about the trust and respect NASA placed in the commander of the first Gemini mission. An experienced test pilot who had made the selection as one of only seven men chosen to be America's first astronauts, Gus Grissom was one of the most senior in the NASA cadre and was determined to make Gemini his own from early on. He approached the task with the steely determination to ensure that Gemini not only flew well but also reflected what the Astronaut Office required of their new spacecraft and launch vehicle, if it was to achieve all that was planned prior to Apollo. The partnership between Grissom and John Young, with his unflappable, calculated engineering mind, was also crucial to the pair achieving what had been set out for this short test flight. These two astronauts were part of the legacy of Gemini 3. They were undoubtedly the tip of a very large iceberg that included workers who had planned, prepared, launched and supported the flight, but it was Grissom and Young who turned Gemini from an unmanned test vehicle into a manned spacecraft. They were first and though others would follow, it would be along the path Grissom and Young had pioneered in those three historic orbits.

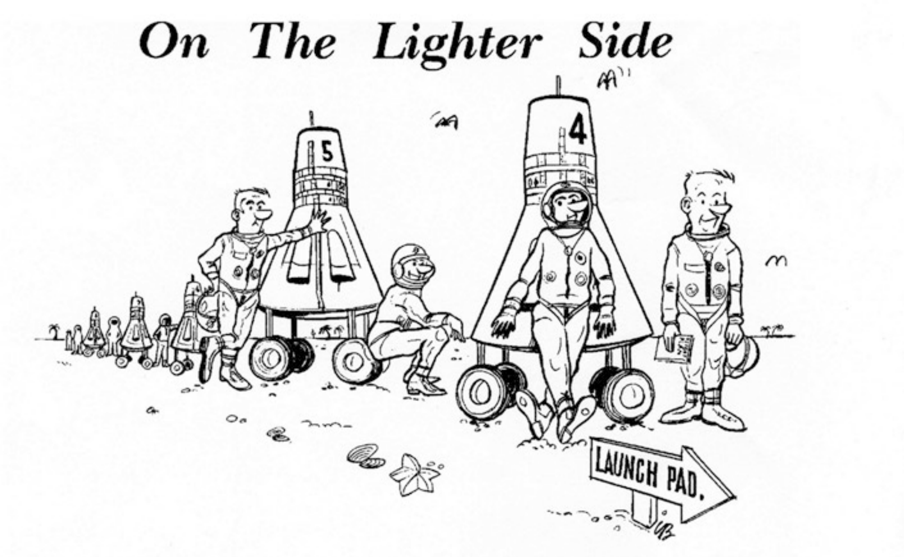
To summarize, let us review once again the primary objectives of Gemini 3 and reflect on the results:

A. Demonstrate manned orbital flight in the Gemini spacecraft and further qualify both spacecraft and launch vehicle systems for future long duration missions. This was *ACHIEVED*, despite a small issue with a leak in an oxidizer discharge pressure transducer seal and the over-performance of the first stage of the Titan.
B. Evaluate the Gemini design and its effect upon crew performance. *ACHIEVED*, with useful comments from the crew on their equipment and procedures for application to the longer missions planned.
C. Exhibit and evaluate operation of the worldwide tracking network with the spacecraft. *ACHIEVED*, with the crew offering operational suggestions to help improve the relationship and working patterns between the ground and the spacecraft and in the handover between ground stations.
D. Demonstrate precise orbital maneuvering using the Orbital Attitude and Maneuvering System (OAMS). *ACHIEVED*, while identifying some small system and procedural errors that would require rectification prior to more extensive rendezvous and docking operations.

E. Verify OAMS capability to perform retro backup. *ACHIEVED*, a useful redundancy in crew safety, offering further confidence in the man-rating of the spacecraft.
F. Evaluate the performance of major spacecraft systems. *ACHIEVED.* Despite some minor issues, Grissom and Young quietly and efficiently put Gemini 3 through its paces in a packed three-orbit mission.
G. Demonstrate the ability to control the re-entry flight path and to arrive at a predetermined landing point. *PARTIALLY ACHIEVED*. Erroneous data from the wind-tunnel tests affected the results, but provided further useful real-time data and experience in returning Gemini from orbit to the ocean.
H. Verify systems checkout, prelaunch, and launch procedures for a manned spacecraft. *ACHIEVED*, with the first full system processing for a planned manned orbital mission in the series and the third processing cycle of the program.
I. Recover the spacecraft and appraise the recovery system. *ACHIEVED*, identifying a more dynamic shift than expected from single- to dual-point parachute suspension, as well as providing real-time experience of recovering a crew from the ocean and the difficulties encountered by a crew during a prolonged stay in the spacecraft after splashdown.

In addition, the crew training and preparation program, as well as the flight control, launch and recovery teams, were given an operational workout on this mission. Then there were the secondary objectives, including:

A. The evaluation of the flight crew equipment, biomedical investigations and the partial personal hygiene system. *ACHIEVED*, with the crew offering useful suggestions for the habitability on board the spacecraft.
B. Perform three small experiments. *PARTIALLY ACHIEVED*. The Sea Urchin Egg experiment was not activated due to faulty equipment, but the flight proved the principal of utilizing Gemini for small experiments to supplement the main objectives and offered in-flight experience that could be utilized for more advanced experiments and investigations on subsequent programs.
C. Evaluate the low-level longitudinal pogo oscillations of the launch vehicle on the flight crew. *ACHIEVED*. The crew reported that the ride on Titan was very smooth. Indeed, in replying to a reporter during a post-flight press conference, when asked to compare Titan with the Redstone used during his flight on *Liberty Bell 7*, Grissom explained that riding on the Titan was more like a Corvette than the Volkswagen of the Redstone.
D. Obtain general photographic coverage from orbit. *PARTIALLY ACHIEVED*. An incorrect lens was fitted to the 16-mm camera and there was significant cloud cover throughout the mission to hinder ground observations and Earth photography tasks. Young's use of the 70-mm camera was deemed very successful, though results were limited due to the short duration of the mission and the busy flight plan.



And so on to the next flight. Gemini 3 had not even cooled down from entry as the next crew and spacecraft were being prepared for their mission. So were the ones after that and soon more were to follow. As this cartoon from MSC Space News Roundup of May 14, 1965 humorously suggests, Gemini spacecraft and their crews were lining up (though not exactly on the beach!) to fly following the success of Gemini 3.

Gemini 3 was deemed an unqualified success, with very few issues to be investigated prior to Gemini 4. But what is the legacy of Gemini 3? Clearly, it is the fact that it qualified the Gemini as a manned spacecraft smoothly and efficiently, thanks to the efforts of the crew and those who prepared the hardware and supported the mission. Gemini 3 has been cited most importantly as the first spacecraft to change its orbit, but it is also remembered for that corned beef sandwich, which is disappointing and, half a century later, annoying. Grissom and Young deserve much better from the pages of history as they achieved a lot in three orbits, fully qualifying the Gemini system for all that it would achieve on the remaining nine missions. They flew what was at best a barely-evaluated manned spacecraft on a trouble-free three-orbit mission, pioneering the use of its systems and procedures for others to follow. They had the confidence and trust in the spacecraft to experience its re-entry and landing qualities for the first time.

Gemini 3 also vindicated the original idea of the Ames Research Center committee chaired by Harry Goett in 1959, which suggested developing an advanced version of the one-man Mercury spacecraft to attempt more far-reaching objectives than Mercury would ever be able to accomplish. Six years later, Gemini 3, Gus Grissom and John Young set the standard for their peers to follow. While the next nine missions would attain remarkable results, set new records and gain valuable experience, the basic mission profile was trialed and pioneered by Grissom and Young on board *Molly Brown*.

By early June 1965, the post-flight mission of *Molly Brown* as Gemini 3 was almost over bar issuing the official reports. The astronauts and the whole Gemini team had moved onwards to the next flight. But above all, what Grissom and Young had proved on Gemini 3 and what *Molly Brown* had demonstrated so well, was that:

GEMINI FLIES!

References

1. MSC Round Up, April 2, 1965, Volume 4, No. 12, p. 1.
2. **Failure is Not an Option**, Gene Kranz, Simon & Schuster, 2000, pp. 130-131.
3. *Astronautics and Aeronautics* 1965, NASA SP-4006, 1966, pp. 150-151.
4. Manned Space Flight Experiments Symposium, Gemini Missions III and IV, held at the Auditorium of the Museum of Natural History, Washington D.C. October 18-19, 1965.
5. *Synergistic Effect of Zero G and Radiation on White Blood Cells, an Experiment for the Gemini III Manned Space Flight*, in the Annual Report Period Ending June 30, 1965 prepared by M. A. Bender, Biology Division, Oak Ridge National Laboratory, Tennessee, August 1966. ORNL-TM-1550; also, *The Gemini 3 S-4 Spaceflight-Radiation Interaction Experiment*, by M.A. Bender, P.C. Gooch and S. Kondo, in Radiation Research Volume 31 Number 1. May 1967 pp. 91-111.
6. *Evaluation and Test Report of Changing from Single-Point Suspension to Two-Point Suspension*, Gemini Program Mission Report, Gemini 3 Supplementary Report 9, prepared by McDonnell Aircraft Corporation, St. Louis, Missouri for the GT-3 Mission Evaluation Team, NASA MSC Houston, Texas, MSC-G-R-65-2 June 1965. From the McDonnell Final Report 0523-055.18 dated June 30, 1965.
7. NASA JSC Oral History Project, Alan M. Rochford, September 15, 1998
8. **On the Shoulders of Titans, A History of Project Gemini***,* Barton C. Hacker and James M. Grimwood, NASA SP-4203, 1977, p. 237.
9. **Deke!** Donald K. Slayton with Michael Cassutt, Forge Books, 1994, p. 149
10. **Moonshot: The Inside Story of America's Apollo Moon Landings**, Alan Shepard and Deke Slayton, with Jay Barbree, Turner Publishing Company, 1994, pp. 179-180.
11. **Schirra's Space,** Walter M. 'Wally' Schirra, with Richard N. Billings, U.S. Naval Institute Press, 1988, p. 149.
12. **Forever Young: A Life of Adventure in Air and Space**, John Young with James R. Hansen, University Press of Florida, 2012, pp. 84-85
13. *Astronautics and Aeronautics*, 1966, p. 338.
14. **Coming Home, Re-entry and Recovery for Space**, Roger D. Launius and Dennis R. Jenkins, NASA Aeronautics Book Series, 2012, pp. 62-69; e-book https://www.nasa.gov/connect/ebooks/coming_home_detail.html.
15. *Gemini 3, A Field Guide to American Spacecraft*, Jim Gerard, www.amerianspacecraft.com last accessed January 5, 2017.

Appendix 1: Gemini 3 Sequence of Events

Adapted from the Gemini 3 post-flight Mission Report – MSC-G-R-65-2 dated April 1965. Times may vary slightly to those quoted in the official air-to-ground commentary due to more in-depth post-flight analysis.

EST Mar 23, 1965	Elapsed time* (hrs:min)	Event
04:40		Crew awoken by Slayton
05:15		Breakfast started
06:02		Crew arrive at Pad 16 for suiting up
06:45		Sensors in place on chests of astronauts Suiting completed
07:05		Leave Pad 16 for Pad 19 (400 yards)
07:09		Ascend Pad 19 elevator to level 11
07:12		Crew enter Gemini 3
07:34		Hatches closed
Ascent phase		
09.24	00:00	Lift-Off
	00:02:33.09	BECO Stage I separation
	00:05:33.75	SECO
	00:05:59.02	Spacecraft separation from launch vehicle
	00:06	Separation maneuver from GLV and insertion Start insertion checklist
	06:11:32	Separation maneuver ended using OAMS aft-firing thrusters added 10.6 ft./sec to spacecraft velocity.
		Entered orbit of 87.0 nautical miles perigee, 121.0 nautical miles apogee.
First orbit		
	00:10	Completed insertion checklist (except for main battery check) Started platform alignment (used caging technique)
	00:12	Completed platform alignment
	00:13	First voice report of yaw drift problem
	00:15	Plot-board un-stowed Switch to UHF no. 2

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9

EST Mar 23, 1965	Elapsed time* (hrs:min)	Event
	00:16	Switched the radiator to FLOW
	00:18	Blood pressure (pilot) Returned the radiator switch to BYPASS
	00:20	Recovered GET time mark to set elapse time watch Activated sea urchin egg experiment
	00:21	Control mode check complete
	00:24	Noted loss of primary dc-to-dc converter and switched to secondary
	00:30	Pilot removed and stowed launch day urine bag
	00:44	Radiator switched to FLOW
	00:47	Respirator maneuver (command pilot)
	00:48	Completion of oral temperature (pilot)
	00:50	Started human blood irradiation experiment
	00:51	Received GO from ground control for second orbit Received 2-1 DCS pre-retro command load Received re-entry quantities and pre-retro update quantities by voice
	00:52	Checked T_r update on time mark from ground
	00:55	Switched the secondary coolant loop OFF and the evaporator to NORMAL
	00:59	Started the RCS plume evaluation
	01:03	Main battery checked
	01:06	Closed both faceplates for ECS check 1
	01:07	Started the catch-up mode check
	01:10	Deactivated the human blood irradiation experiment
	01:12	Completed the catch-up mode check
	01:14	Activated O_2 High Rate using manual handle (attempt to lower primary O_2 pressure)
	01:15	Started platform alignment Activated sea urchin egg experiment Re-cocked O_2 High Rate
	01:24	Recovered DCS maneuver update for translation no. 2
	01:33	Started translation no. 1 using forward-firing thrusters (small end forward) to lower apogee to 93 nautical miles
	01:34	Completed translation no. 1 (duration of translation controlled in time, $\Delta t = 75$ sec) 49ft/sec resulted in perigee of 85.6 nautical miles and apogee of 91.2 nautical miles
	01:35	Initiated manually-controlled dump of delayed-time tape recorder data
	01:37	Recovered 3-1 DCS pre-retro command load
	01:40	Received update time for horizon scanner check Blood pressure (pilot)
	01:41	Tape dump complete
	01:46	Start of platform alignment and caging check (command pilot) Start of food and waste evaluation (pilot)
	01:49	Command pilot attempted to obtain a blood pressure reading
	01:54	Completed platform alignment and caging check. Spacecraft yaw 180° in preparation for horizon scanner check
	01:58	Onboard report that 8-ball and horizon did not agree. (First indication of platform orbit rate problem)

EST Mar 23, 1965	Elapsed time* (hrs:min)	Event
Second orbit		
	02:06	Horizon scanner check started
	02:16	Report of 8-ball and horizon disagreement
	02:16:59	Three small out-of-plane maneuvers performed with spacecraft over the Indian Ocean
	02:17	Translation system check
	02:17:25	Maneuvers completed ΔV was approx. 10ft/sec towards North
	02:24	Start of platform alignment
	02:30	Horizon scan control mode characteristics check deleted (command pilot evaluating platform problem and assisting with the food and waste evaluation)
	02:35	Continued with platform alignment (stars used for attitude reference)
	02:41	Start of O_2 High Rate check
	02:43	Main batteries ON
	02:45	Manual ECS O_2 heaters - ON
	02:46	O_2 High Rate rechecked Manual ECS O_2 heaters - OFF
	02:52	Gauge correlation report started
	02:55	Platform SEF mode checked and reported operating correctly
Third orbit		
	02:58	Gauge correlation report completed
	03:02	Start of tracking task – tracked Mexicali, Mexico
	03:02	Coolant pump checks completed
	03:06	Standby telemetry transmitter used to transmit real-time telemetry data
	03:11	Checked platform orbit rate mode
	03:13	Cabin fan switched ON
	03:15	Cabin fan switched OFF
	03:19	Started platform stabilization check
	03:24	Completed platform stabilization check and started control mode characteristics check
	03:24	Completed control mode characteristics check
	03:51	Activated sea urchin egg experiment
	03:56	Pre-retro checklist complete
	03:59	Started even-time counting down to retro-fire
	04:00	Switched computer to catch-up
	04:12	Main battery check
	04:21:45	Started OAMS retro translation (96 ft./sec)
	04:23	Completed OAMS retro translation. 111-second duration resulted in 98.4 ft./sec
	04:25	Computer switched to re-entry mode
Entry phase		
	04:29	T_r –5 min checklist complete
	04:32	R_r –1 min checklist complete
	04:32:28	Equipment section separated
	04:33:23	Auto retrofire – sequence 1, 3, 2, 4
	04:33	Manual retrofire pushed
	04:34:08.6	Retro section jettison (The spacecraft attitude at this time was approximately 0° roll, –16° pitch, 180° yaw)

EST Mar 23, 1965	Elapsed time* (hrs:min)	Event
	Unknown	Spacecraft rolled to 180° (0° bank)
	04:37:36	400,000 ft. calculated by computer (no spacecraft action)
	04:39:26	Spacecraft rolled to a 45° bank (45° roll left)
	04:39:59	Spacecraft entered blackout
	04:40:26	Grissom began the range needle control technique of re-entry
	04:41	Downrange and cross-range errors displayed by the computer
	04:41	Re-entry communications experiment started
	04:43:51	Cross-range FDI indication nulled, spacecraft rolled to a 0° bank (180° roll, full lift)
	04:45	End of blackout
	04:46	Re-entry communications experiment completed
Recovery phase		
	04:46:51	Drogue parachute deployed manually
	04:47	Drogue parachute deployed
	04:48	Main parachute deployed
	04:48:24	Pilot parachute deployed
	04:48:24	Drogue parachute deployed
	04:49	Post main checklist
	04:52:31	Landing

*Time to nearest minute

Gemini 3 Major Post-flight Activities

March	
23	Gemini launch viewed by Vice President Hubert Humphrey at the Cape USS *Intrepid* served as prime recovery vessel for crew and spacecraft Preliminary post-flight medicals completed on *Intrepid* Telephone call from President Johnson Debriefing commenced Gemini 3 *Molly Brown* retrieved Astronauts inspected spacecraft
24	Debriefing sessions continued Addressed *Intrepid's* crew
25	Left *Intrepid* for Cape Kennedy, Florida Completed 4 hours of medical tests Re-united with family members Parade at Cocoa Beach Post-flight press conference, Carriage Motel, Cocoa Beach, Florida
26	Flew to Washington D.C. Met President Johnson at the White House Parade down Pennsylvania Avenue to the Capitol Visited Smithsonian Institute Attended Congressional reception Astronauts and their families flew back to the Cape for weekend Gemini 3 *Molly Brown* arrived back at Cape
27-28	Families spend a private and quiet weekend at the Cape

29	Astronauts and families flew to Newark, New Jersey, then on to a tickertape parade down Fifth Avenue and celebrations in New York City, New York Visited United Nations Guests of Honor New York City Reception
30	Astronauts and wives flew to Chicago, Illinois Tickertape parade and celebrations Official luncheon and formal reception Q&A with local students
31	Returned to Houston, Texas. Civic reception Parade
April	
1	Short ceremony at NASA Manned Spacecraft Center, Clear Lake, Houston, Texas. Flag raising ceremony
24	1st ‘John Young Day’, in home town of Orlando, Florida Parade and reception
May	
3	John Young receives USN Astronaut Wings at the Pentagon, Washington D.C.
30	Gus Grissom home town reception and parade, Mitchell, Indiana

Appendix 2: Gemini Boiler Plate and Test Articles

Under their contract with NASA, in addition to supplying 12 flight vehicles and seven target docking adapters, McDonnell were also responsible for the construction of a total of six boilerplate spacecraft, four (completed) static test articles, a number of static adapters and a variety of other test vehicles to support the test and evaluation phase of the Gemini design prior to the operational flights.

Generally, the three Gemini missions, Gemini 1 (unmanned, orbital, formally 3-orbits), Gemini 2 (unmanned, suborbital) and Gemini 3 (manned, 3-orbits) can be categorized as test-flights, but there was also a series of ground-based tests to supplement the various system, sub-system and procedure tests, simulations and evaluations, which were completed using a variety of test vehicles. The majority of the structural and dynamic tests were completed between July 1963 and April 1965 using static test articles number 3 and number 4. In addition, static test articles were used to evaluate the Rendezvous and Recovery Section (R & R) and the Re-entry Control System (RCS). These test vehicles, briefly, were:

Gemini Boiler Plates (BP)

Boilerplate, or mass simulator versions, are nonfunctional craft or payloads built at a lower cost than a flight vehicle for testing a variety of configurations and simulations. Boilerplates are also used to test components and sub-systems prior to installation in a flight vehicle. They were used for mating/demating tests, emergency egress and access, in support of maintenance and for simulated parts of a mission. The term originates from the 1850s, when rolled iron or steel was used to make the outer shells of a ship's water boiler. The structure or components were usually heavier than the flight model, but the overall boilerplate copy was not necessarily heavier than the actual item. For Gemini, the mass and center of gravity of a boilerplate was normally the same as the spacecraft.

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9

Boilerplate #1: A steel mockup of the Gemini Re-entry Module, used mainly in development testing with ballast installed to replicate the spacecraft's weight and center of gravity. After fabrication at McDonnell, this unit was sent to North American Aviation for further testing but was destroyed during drop testing at El Centro, California, on July 30, 1963.

Boilerplate #2: A welded steel mockup of the pressurized crew compartment, this unit was a close replica of the flight article in both shape and volume. It was used to evaluate the Environmental Control System (ECS) under simulated mission conditions, examining the effects of solar radiation and equipment heat exchange. This boilerplate featured a complete ECS with related crew station controls. The ECS was instrumented to record and evaluate the performance of the system during both nominal and secondary operations. These tests encompassed regular mission phases as well as failures and off nominal situations, including crew 'ejection' during prelaunch and re-entry modes. On April 9, 1963 this boilerplate was shipped from McDonnell to NASA MSC to be used in further testing.

Boilerplate #3: Another welded still mockup that replicated the actual flight spacecraft aerodynamically. This boilerplate was assigned to the development of the ejection seat and was used in rocket sled tests. The primary features of this unit were the two pilot seats, the seat rails and the seat actuating mechanisms. The Adapter Retrograde Section was simulated with a removable fairing and the two crew hatches were of the correct design but fixed in the open position for the tests, as there were no plans to replicate the hatch opening sequence. In July 1962, this unit was shipped to Weber aircraft for the test program. Unfortunately, the vehicle incurred extensive damage on the first sled run when one of the pusher sled rockets failed. After repairs, the unit was utilized in further sled testing of the ejector seats.

Boilerplate #3A: Basically similar to Boilerplate 3, this unit had the additional features of a production-class large pressure bulkhead, a seat rail torque box, two hatch sills, two side panels, two 'light' hatches and two flipper doors. At McDonnell, the unit underwent hatch firing functional tests prior to delivery to Weber Aircraft, where it completed escape system qualification tests. These included both Simulated Off the Pad Ejection (SOPE) and further sled runs comprising system tests and sequencing of the pyrotechnics in the ejection system. This series of tests took place through most of 1964 and into the first months of 1965.

Boilerplate #4: This unit was different to those mentioned above, as it was built by Weber Aircraft and delivered to McDonnell instead of the other way around. This re-entry module was made from an aluminum skin and stringer construction. To replicate an actual production spacecraft, it was designed to carry ballast to simulate the eight center of gravity (CG) and moments of inertia of a flight vehicle. Delivered to McDonnell on October 21, 1963, this unit was intended for use in evaluating the land-landing skid-gear, but when that requirement was deleted from the program, it was instead used in a series of drop tests at McDonnell.

Boilerplate #5: Another welded steel mockup of the Re-entry Module, with provisions for ballast to simulate spacecraft weight and CG, this unit was used in the development of the parachute recovery program. It was shipped to Northrup-Ventura on August 31, 1962 and was used for parachute testing. Following these tests, the unit was refurbished and converted into Static Article 4A (September 18, 1964), before being used in high-altitude drogue parachute qualification tests together with Static Article 7.

Gemini Static Test Articles (STA):

Static Test Article #1: Cancelled by agreement between NASA and McDonnell, with its Re-entry Module and Adapter reassigned to Spacecraft 3A (see below).

Static Test Article #2: Intended as a manned Re-entry Module to be used for qualification of the NAA paraglider known as the Rogallo Wing. It was cancelled when the Rogallo Wing was deleted from the Gemini program.

Static Test Article #3: A complete Re-entry Module of the early Rogallo Wing configuration, with Adapter Module, delivered to NASA on May 15, 1963. The difference between this and the 'standard' Re-entry Module was the inclusion of the Rogallo Wing torque box structure, which was located between the two crewmember hatches and which could also accommodate parachute fittings. This enabled it to be used in either the Rogallo Wing or parachute configuration. During launch and abort tests, a Martin No. 2 Adapter was mated to the Re-entry Module and following its use on the test program, this unit was reassigned to the USAF Manned Orbiting Laboratory Program (MOL) for testing.

Static Test Article #4: Similar to STA-3, but with dummy equipment to simulate the mass and CG of a flight vehicle. Delivered on April 18, 1963, it was used to conduct dynamic response tests, tests of the seat and hatch backup structure and ultimately, pressurization tests. It was also used for drop tests in water and for hoist and loop support tests simulating the end of mission recovery of the Re-entry Module from the ocean. Once again, this STA was transferred to the USAF MOL Program after these tests were completed.

Static Test Article #5: Used for floatation stability tests and as a crew egress trainer. This unit resembled a complete re-entry vehicle without the Adapter. All the equipment exterior to the pressure vessel and critical to the floatation of the flight spacecraft was closely simulated, to ensure the correct floatation attitude was replicated when this unit was placed in the water. In addition, in preparation for the first manned flight, the weight and CG duplicated that of Spacecraft 3 (*Molly Brown*). Water floatation tests were completed at the McDonnell facility and the unit was subsequently modified to be used as an egress trainer. Those modifications included systems that would be operative after splashdown, such as a partial ECS and communication systems. Ballast and CG was provided, but all external equipment unnecessary for these tests was simulated. There were dummy ejection seats, only a partially operative instrument panel and operating recovery equipment. Though never used, there was also provision for the land-landing gear. Following these modifications, this unit was delivered to NASA for astronaut egress training.

Static Test Article #6: Originally intended as a backup unit to STA-2, it was deleted with the cancellation of the Rogallo Wing.

Static Test Article #7: Delivered to NASA on January 2, 1964, this unit was used to qualify the parachute recovery system and therefore no Adapter was fitted. The boilerplate pressure vessel with heat shield featured a production RCS and R&R sections. It did feature all the necessary systems to qualify the drogue, pilot and main parachute assemblies completely.

Static Adapters (SA) (Used During the Development of the Gemini Adapter Section):

Static Adapter #1: This unit was completed by McDonnell and shipped to Martin in early 1963. It was then used for structural dynamic and related structural tests. In December 1963, it was returned to McDonnell for a series of dynamics response tests, where dummy equipment of the correct weight and CG was installed in the Adapter shell to test responses.

Static Article #2: This unit had a checkered history. Originally, the construction on this unit was stopped on October 1962 due to budget restrictions. However, when the 'Popgun' program was initiated, SA-2 construction was reinstated to replace the SA-4 in the structural test program. 'Popgun' was an analytical model developed in 1962 by Richard E. Martins of the Gemini propulsion group at McDonnell, in which he described the 'pop gun' phenomena of a Gemini Mode II abort scenario. He later monitored the test program in the emergency separation procedures. Once completed, the Retrograde section of SA-2 was attached to SA-4 for dynamic response testing. Later, the equipment portion of the Adapter was added, allowing for further dynamic testing. Following these tests, the combined SA-4/SA-2 Adapter was returned for additional modification. It was subsequently joined to re-entry test unit #3 for static tests of the 'cold' launch conditions.

Static Adapter #3: Used to qualify the equipment mounts in the Adapter, the retro-rocket support structure, the blast shield access door and the Adapter itself in 'hot' launch conditions.

Static Adapter #4: Completed one pyrotechnic separation test at the station Z 13 location (where the Adapter mates to the Titan second stage). This Adapter was reassigned to the 'Popgun' test program. 'Popgun' tests involved pyrotechnic separation at the station Z 69 point (where the Adapter mates to the Retrograde Section) but proved inconclusive following considerable damage caused by a rocket assembly failure. The undamaged structural ring from the Retrograde Section was removed and used in the construction of a boilerplate

Adapter that showed no Popgun effects for the continuation of Popgun testing. Subsequently, Static Article number 4 Adapters were used for another pyrotechnic separation test at the Z 13 point.

Miscellaneous Test Vehicles

Thermal Qualification Test Vehicle: This test unit was one of the thirteen complete production re-entry spacecraft units fabricated by McDonnell. It was not used as a flight spacecraft but instead, with the addition of a test adapter, was used in the ground testing program in the run up to Gemini 3. Designated Spacecraft 3A, it was delivered to the laboratory at McDonnell on October 15, 1964 for the thermal qualification test program that ran through to February 1965. This vehicle included flight-standard systems and subsystems as well as qualified production items. It was lacking some easily replaceable items of equipment, such as the heat shield and ejection seats, but after authorization from NASA, McDonnell substituted the missing items with non-flight articles. This series of qualification tests featured mission simulation runs, during which each system was operated as they would be on a real spaceflight. However, due to safety rules in the use of a vacuum chamber, hypergolic and cryogenic hydrogen were not used and were substituted by inert fuels and bridge wire-type pyrotechnics. As Spacecraft 3A, this vehicle also completed vibration and Spacecraft Systems Tests (SST).

Electronics Systems Test Unit (ESTU): This unit featured a simplified Re-entry Module mockup, but with provision to mount all electronic components in their correct flight locations. Initially, prototype and early production units were installed and used to simulated spacecraft wiring conditions. At first, each component, subsystem or system was tested individually, then linked together system by system. This provided the engineers with an initial evaluation of each individual component and how they did, or in some cases did not, integrate with each other, gradually building up the spacecraft's electrical network step by step. This unit was first activated on November 19, 1962 and was used to evaluate early problems and corrective actions. Subsequently, a duplicate configuration to that of Spacecraft 2 was installed and thoroughly tested prior to that mission.

Compatibility Test Unit (CTU): Replicating the flight article, this unit was a mockup of the spacecraft and featured standard wire bundles. Prototype spacecraft systems were installed and tested. These tests provided an operational systems representation for Spacecraft 1, then 2, followed by 3 as well as 3A. The objectives of this test program were: to provide compatibility testing of spacecraft systems and prevent interference, including radio-noise; establish compatibility between the spacecraft and ground support equipment (GSE); provide evaluation and staff training prior to testing the production spacecraft; and provide a viable test bed to evaluate subsequent upgrades to equipment, as well as to investigate problems as the program progressed.

Specimen Hatch: Delivered in July 1963, this unit was used to test the Gemini hatch design and system. To test the structural integrity properly, a portion of the large pressure bulkhead had to be fitted to the unit. This unit featured the Gemini production hatch sill, side panels, hatches and latch mechanism, mounted on a boilerplate box assembly. A variety of tests were accomplished on this unit, including latch rigging, function and leakage tests, as well as static structural tests of the aft hoist loop fitting.

R & R and RCS Pyro Test Unit: This unit featured a full production R & R/RCS section and, initially, equipment for the Rogallo Wing. The unit was primarily designed for pyrotechnic demonstrations of the following operations: the drogue mortar; the separation of the nose fairing; Mild Detonating Fuse (MDF) ring separation at the Z 191.97 point; nose landing gear deployment (deleted after the cancellation of the land-landing capability); emergency docking release deployment; and the docking bar assembly deployment. Originally, this unit was to have been delivered in mid-December 1963, but the cancellation of the Rogallo Wing resulted in major modifications and a delay in delivery until the first quarter of 1964.

R & R and RCS Structural Test Unit: Once again, this unit was intended to have a Rogallo Wing-type R & R section, but instead a parachute RCS was used to qualify the radar support, RCS parachute support and the nose fairing structures. Subsequently, additional testing with this unit included drogue parachute structure qualification under re-entry temperatures. Other testing included the performance of the pyrotechnic separation of the MDF ring at the Z 191.97 point. When these tests had been completed, this unit was installed on Static Article 3 for high-temperature parachute deployment tests.

[The information presented here is adapted from Project Gemini: A Technical Summary, by P.W. Malik and G. A. Souris, McDonnell Douglas Corporation for NASA MSC, June 1968 NASA CR 1106, pp16-22]

Appendix 3: Gemini 3 Experiments

During the development of the longer duration Gemini program, NASA recognized the opportunity to expand the program of small scientific, biological and technical experiments conducted during the Mercury flights. These experiments were proposed by NASA field centers, the Department of Defense and the scientific community.

The nature of the first two unmanned Gemini missions meant that these experiments would have to wait until after the test-flight qualification of the launch vehicle and spacecraft. Gemini 3, therefore, provided the first real opportunity to fly these small investigations. However, due to the short duration of the flight and the already-busy schedule of the crew, the number was restricted to just three main experiments, each requiring minimal crew time.

Re-entry Communications (Technological Experiment T-1)

Any item entering the atmosphere of Earth from space generates an extremely high temperature. As the temperature rises, the 'air' around the spacecraft ionizes and creates a sheath of plasma, surrounding the object descending through the thickening layers of the atmosphere. The consequence of this for a manned or unmanned operational spacecraft is that radio communications with it are blocked. Each of the returning Mercury spacecraft endured this loss of both telemetry and voice communications during re-entry, more generally known as a 'blackout'. During this period of the mission, the spacecraft and its occupant were literally 'on their own' as they plummeted to Earth.

Naturally, it would be highly desirable not to have any such break in communications with the spacecraft or crew and numerous experiments and investigations had been conducted with the aim of solving this problem. One group of experiments that showed promising results were those which injected fluid into the ionized plasma, thus decreasing the level of ionization and allowing the passage of communications. This method had been proven successful for an object with a maximum nose diameter of just 8 inches (20.32 cm) at velocities of up to 18,000 ft./sec (5,486.4 m/sec) or 12,270 mph (19,746 kph). Of course, a spacecraft with the mass of Gemini, at about 4,369 lbs. (1,982 kg), a heat shield diameter

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of 90 inches (228.6 cm) and returning from orbital velocity of 17,500 mph (28,163 kph), was a much more challenging problem, but the experiment assigned to Gemini 3 was designed to determine if this technique could be applied to a larger, blunt-body, high-velocity object returning from Earth orbit.

With far wider application than just the civilian program, as it was planned to use the Gemini spacecraft for crew transport in the USAF Manned Orbiting Laboratory, this investigation was sponsored by NASA's Office of Advanced Research and Technology and was designed at the agency's Langley Research Center in Hampton, Virginia. Three experimenters from Langley, Theo Sims, William. F. Cuddihy and Lyle. C. Schroeder, were involved in the studies. This was classed as an engineering experiment for GT-3.

The experiment was designed to inject water into the ionized plasma sheath in very brief, timed pulses during the re-entry phase. The level of signal received on the ground at Key West and Homestead, Florida, as well as via high-flying aircraft, would be monitored and recorded to evaluate the effectiveness of the different known flow rates. Though the plan was eventually to restore direct astronaut voice channel communications, on this flight it was only intended to measure telemetry signals.

Using the redundant, but still accessible, right main landing gear door on the Re-entry Module, the 85 lbs. (38.55 kg) experiment featured a water expulsion system fitted inside the door. The blackout period starts at approximately 300,000 feet (91,440 m) and at a specified time, the pilot (Young) simply had to flick a switch to start the experiment, the only involvement by the crew. This action opened a solenoid shut-off valve which pressurized the water storage tank by injecting nitrogen gas and simultaneously initiated the mechanically-run injection sequence timer. This activated the injection nozzle solenoid valves at preset programmed times, allowing the ejection of water into the flow field. The water supply was completely exhausted after about 1,050 seconds, ending the experiment.

Effects of Zero Gravity on the Growth of Sea Urchin Eggs. (Space Science Experiment S2)

The objective of this experiment was to investigate the effects on the growth of cells when exposed to low-gravity conditions. Simple cells such as sea urchin eggs were chosen instead of more complex systems, in order to identify any changes more easily. The sea urchin cells would be used to study the effects of 'zero-gravity' during fertilization and cell division. A control set of samples would be developed simultaneously at the launch site for post-flight comparison.

Mounted inside a 25.4-ounce (720 gram) metal cylinder measuring 3.25 inches (8.24 cm) diameter and 6.75 inches (17.14 cm) long, located in the cabin's left-hand hatch, the experiment consisted of eight separate samples of sea urchin eggs, sperm and a fixative solution. Sponsored by the NASA Office of Space Sciences, the experiment was conducted by NASA's Ames Research Center, with Dr. Richard S. Young of Ames as the experimenter. (Note: Some documentation describes the experiment as a 10 oz. (283 gram) cylinder, with some eggs fertilized before launch and others fertilized during flight.)

At a designated time in the flight plan, a crewmember would rotate a handle at one end of the cylinder to start the experiment. This action brought together the eggs and sperm to start the fertilization process. After a specified time, the fixative solution would be applied to the egg embryo to stop its growth, with the astronaut again rotating the handle to stop the experiment. The cylinder was designed to permit activation of the fertilizer or fixative in a prearranged sequence.

Effects of Zero Gravity and Radiation on White Blood Cells. (Space Science Experiment S4)

This experiment was created to examine the biological effects of radiation on human white blood cells. This was an important field of research because of the potential harmful effects of radiation levels during long-duration spaceflight. Since the Gemini missions were planned to last up to 14 days, this was a significant experiment in support of both these and much longer missions planned for later programs. The objective of the experiment was to determine the possibility that the onset of weightlessness and the radiation dosage received combined to produce a more detrimental effect than if their individual effects were measured. Conducted by the Atomic Energy commission and sponsored by the NASA Office of Space Sciences, the principle investigator for this experiment was Dr. Michael A. Bender of Oak Ridge National Laboratory, Tennessee.

By exposing samples for about one hour to a known quantity and quality of radiation, the experimenters could measure any changes in the samples exposed during the zero-gravity phase of the mission. A control set would be kept at the launch site and exposed at the same time as the set on Gemini 3. In addition, analysis of blood samples taken from Grissom and Young immediately prior to and following their mission would be used in the investigations.

This experiment was housed in a hermetically sealed aluminum box measuring 3.7 inches (9.4 cm) wide, 1.3 inches (3.3 cm) deep and 3.8 inches (9.6 cm) long, with a mass of approximately 1 lb. (0.45 kg). It was located on the inside of the right-hand hatch. The radiation source was Phosphorous-32, an isotope which emits a single beta particle with an average of 0.7 meV. The irradiation of the samples stored on board was initiated by a crewmember manually twisting a handle on the box.

Other Investigations

In addition to the three main experiments, there were other investigations assigned to this first manned Gemini mission, which had direct application to longer, more complex missions.

Medical:

There were medical tests assigned to Gemini 3 pending more extensive life sciences experiments on the longer flights. Throughout the flight, readings of the medical condition of both Grissom and Young would be taken by biomedical telemetry sensors stuck to their bodies and from interpreting voice communications. This data would be used to evaluate not only the general condition of the crewmembers, but also their blood pressure and temperature, as well as their general state of relaxation, stress and alertness during the flight.

One of the ongoing studies begun during Project Mercury was the investigation of the *Cardiovascular Effects of Spaceflight* during exposure of the cardiovascular system to prolonged weightlessness. Data from the six-orbit, 8-hour Mercury 8 flight by Wally Schirra in October 1962 and the 22-orbit, 34-hour Mercury 9 flight by Gordon Cooper in May 1963 had revealed that both astronauts experienced a lower than normal blood pressure when they stood up immediately after extraction from their spacecraft.

To compare the data with the Mercury astronauts, Grissom and Young were supposed to remain inside the spacecraft until it had been hoisted aboard the prime recovery vessel, but the conditions inside Gemini 3 changed this. Prior to leaving their crew stations in the original plan, each astronaut would have been attached to a portable biomedical recorder to capture their blood pressure and electrocardiogram data before they left the spacecraft and stood upright on the deck of the recovery vessel. Blood pressure and ECG measurements would have been automatically recorded before, during and for a short time after their egress. The two astronauts would then undergo tilt table tests in the ship's medical facility. Measurements would be taken before, during and after a head-up tilt of 80 degrees from the horizontal.

All this data would have given the medical team pre- and post-flight samples of blood pressure, blood volumes, pulse rates and an electrocardiogram on each astronaut. The results were expected to reveal changes in the cardiovascular and blood volume due to heat stress and the effects of prolonged confinement in the spacecraft, as well as dehydration fatigue and possibly the effects of weightlessness. There were no requirements to take any of these medical measurements during the flight.

The experiment, which would potentially have implications for the longer flights of Gemini, was conducted on behalf of the Space Medicine Branch of the Crew Systems Division at MSC, and was sponsored by the Office of Manned Space Flight.

Evaluating Space Food

As flights into space increased in duration and involved larger crew numbers, the need for a more nutritious and varied diet for the crew became a requirement. Though not exactly gourmet dining, the plan was for Young to evaluate packaging, handling and edibility of the flight food during one hour on the second orbit. The evaluation of the food packaging and handling was especially important in planning longer missions of up to two weeks and for long lead planning for the Apollo lunar missions.

For Gemini 3, two meals were provided of four items each. Each meal was packaged in an aluminum foil laminated over-wrap. Each meal featured two rehydrated items and two bite-sized items, sugarless chewing gum and a wet pack for cleaning the hands and face. Located in a storage box on the left side of the Gemini, it was planned that Grissom would transfer the meals across to Young who would evaluate them during the second orbit.

Using a water gun specially developed by the MSC engineers, Young would reconstitute the rehydrated items by inserting the gun into the nozzle in the food package and pulling the trigger, the idea being to inject water into the food without spilling any. The bite-sized food was not rehydratable but could be eaten from the package because they were coated to prevent crumbling. To open the packages, Young had stowed a pair of scissors in the left leg pocket of his spacesuit.

After eating the food, Young had to evaluate the waste disposal procedures for dealing with the empty packaging. In a separate pouch, a yellow tablet of food disinfectant was included in each pack of the freeze-dried food. The tablet would react chemically with any remaining food when placed in the opened package to prevent spoilage. To meet flight safety standards, all food items had to conform to stringent bacteriological requirements, set much higher than the normal industry requirement on commercially processed foodstuffs. Once again turning to the U.S. military for inspiration, this food experiment had been developed by the U.S. Army Laboratories, Natick, Massachusetts. Whirlpool Corporation of St Joseph, Michigan were responsible for the procurement, processing and packaging of each of the food items, with the actual food supplied by sub-contractors Swift and Co. of Chicago and Pillsbury Co. of Minneapolis

The meals for Gemini 3 evaluation were:

Meal A
Beef Pot Roast – consisted of freeze-dried beef cubes in gravy, shaped into a bar (27 grams or 0.95 oz.) and formed from a recipe of cooked diced beef, beef juices and water.
Orange Juice – This consisted of 20.7 grams (0.73 oz.) of orange juice crystals and 0.3 grams (0.01 oz.) of orange oil granules.
Meal B
Apple sauce – This was a commercially-prepared instant powder with a mass of 42 grams (1.48 oz.), containing a mixture of instant apple sauce and instant apple juice.
Grapefruit juice – another commercially-prepared instant powder, weighing 21 grams (0.74 oz.)
Brownies – Composed into cubes by special drying procedures, each had a double coating of starch and gelatin. The contents of these were shortening, bitter chocolate, general purpose flour, chemical leavening, salt, white fresh eggs, granulated sugar, vanilla flavoring and midget pecans. The mass for six cubes was 45 grams (1.58 oz.)
Chicken Bites – Six pieces, freeze-dried, weighing a total of 24 grams (0.84 oz.). These consisted of diced chicken, water, gravy mix, shortening and minced onion.

Waste Management System Evaluation

The longer the flight, the greater the problem of managing and stowing human waste. For the relatively short flights of Mercury, of a few hours or up to one day, the problem was not so difficult to overcome, but for the longer duration Gemini flights, the facilities had to be reliable, sanitary and also personally acceptable to the crewmen. Added to this, Gemini still had a relatively limited internal volume. With two astronauts rather than one and missions planned for up to 14 days (28 man-days), some ingenious solutions had to be devised. Some of these were evaluated on Gemini 3, with John Young once again the primary test subject. Two urine collection devices were worn, one during pre-launch while the spacecraft was on the pad and for the launch phase, with the other an in-flight urine transport system that was for use in orbit. A third device was the fecal waste management system.

Photography

For general purpose and Earth terrain photography, the crew were provided with a 70-mm Hasselblad camera and a 16-mm motion picture camera.

Spacecraft Habitability

In addition to the numerous engineering, technical and spacecraft systems evaluations and procedures for this first Gemini mission, the crew was also tasked with providing a commentary on the habitability of the spacecraft with a view to the long-term planning of the longer flights and the more complex rendezvous and docking missions. This extensive evaluation and testing program on such a short flight curtailed the general chat from the astronauts to the ground, a fact picked up and unfairly criticized by the media, who were searching for good copy rather than reporting on the importance of what Grissom and Young were trying to accomplish in such a short time in preparation for the longer flights.

Bibliography

During the compilation of this first book of a planned series on each Gemini mission, significant reliance on a number of key documents was crucial, not only for this current volume but also for those which follow. These documents were frequently referred to and cited throughout the book and are the primary references for this and other titles in the series.

NASA Publications

1966 *Gemini Mid-Program Conference, including Experiment Results,* February 23-25, 1966, Manned Spacecraft Center, Houston, Texas, NASA SP-121.

1967 *Gemini Summary Conference,* February 1-2, 1967, Manned Spacecraft Center, Houston, Texas, NASA SP-138.

Summary of Gemini Extravehicular Activity, Edited by Reginald M. Machell, Manned Spacecraft Center, Houston, Texas, NASA SP-149.

1968 *Project Gemini: A Technical Summary,* P.W. Malik and G. A. Souris, McDonnell Douglas Corporation, NASA Contractor Report CR-1106. June 1968.

1969 *Project Gemini, a Chronology,* James M. Grimwood and Barton C. Hacker with Peter J. Vorzimmer, NAS SP-4002.

1977 *On the Shoulders of Titans, A History of Project Gemini*, Barton C. Hacker and James M. Grimwood, NASA SP-4203.

1988 *NASA Historical Data Book, Volume II, Programs and Projects 1958-1968*, Linda Neuman Ezell, NASA SP-4012.

Gemini 1, 2, & 3 Books, Documents & Reports

Gemini 1

1964 *Gemini 1 News Release (Press Kit)* NASA Release 64-70, April 2, 1964.

Gemini 1 Mission Report, May 1964, MSC-R-G-64-1.

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9

Gemini 2

1964 *Gemini 2 Press Kit,* NASA Release 64-296, December 4, 1964.
1965 *Gemini 2 Mission Report*, February 1965, MSC-G-R-65-1.

Gemini 3

1965 *Gemini 3 Press Kit,* NASA Release No. 65-81, March 17, 1965.
Gemini 3 Mission Report, April 1965, MSC-G-R-65-2.
Gemini 3 Flight Crew Technical Debrief, NASA Program Gemini Working Paper No. 5025, MSC, June 3, 1965.
Gemini 3 Air-to-Ground Voice Transcript, Supplemental Report 5, NASA MSC-G-R-65-2, June 23, 1965.
Manned Space Flight Experiment Symposium, Gemini Missions III and IV, NASA October 1965.
2014 *Gemini 3, The NASA Mission Reports*, No. 89, Steve Whitfield, Apogee Prime Books.

Other General Books on the Gemini Program

2001 *Gemini: Steps to the Moon,* David J. Shayler, Springer-Praxis.
2004 *How NASA Learned to Fly in Space, An Exciting Account of the Gemini Missions,* David M. Harland, Apogee Books.
2015 *NASA Gemini 1965-1966 (all missions, all models) Owners Workshop Manual,* David Woods and David M. Harland, Haynes Publishing.
2016 *Project Gemini*, America in Space Series, Eugen Reichl, Schiffer Publishing Ltd.

Books by or About the Gemini 3 Astronauts

In any research such as this, it is not always possible to interview the participants personally; therefore, it is useful to have their own account, or cooperative story, at hand. From the more formal 'pilot' reports often recorded shortly after the completion of the flight, it is possible to gain a greater insight into how a mission progressed or how activities or incidents were handled. The personally-authored biographies or autobiographies can often add additional detail, personal opinion or explanations that were not forthcoming in the more 'official' accounts of the mission. Over the years, there have been a number of such books which have focused upon the prime crewmembers of Gemini 3.

<u>Virgil I 'Gus' Grissom (Gemini 3)</u>

Naturally, most of these titles tend to focus on Command Pilot Gus Grissom, his life and his career, both prior to and after Gemini 3 and leading up to Apollo 1 and its aftermath. These titles are:

1968 *Gemini,* Gus Grissom, Macmillan.
Seven Minus One, The Story of Gus Grissom, Carl L. Chappell, Pinaire Lithographic Corporation.

1974 *Starfall*, Betty Grissom and Henry Still, Thomas Y. Crowell Company.
2004 *Gus Grissom, The Lost Astronaut*, Ray E. Boomhower, Indiana Historical Society Press (2011 Reprint).
2016 *Calculated Risk, The Supersonic Life and Times of Gus Grissom,* George Leopold, Purdue University Press.

John W. Young (Gemini 3 and Gemini 10)

It has often been a challenge to secure a personal interview with John Young, so that the outcome of his decision, shortly after he retired from NASA in 2004 following an impressive 42-year astronaut career, to sit down and finally co-write his biography was much anticipated:

2012 *Forever Young, A Life of Adventure in Air and Space,* John W. Young with James R. Hansen.

Other references sourced during the compilation of this book were:

Periodicals

Aviation Week and Space Technology
Flight
MSC Roundup
Spaceflight (British Interplanetary Society)
Quest

Newspapers

Chicago Tribune
Florida Today
Houston Chronicle
Houston Post
Life Magazine
New York Times
Orlando Sentinel
The Daily Telegraph
The Times, London
Sydney Times, Australia
Washington Post

Reports

1963 *Astronautical and Aeronautical Events of 1962*, Report of NASA to the Committee on Science and Astronautics, U.S. House of Representatives, 88th Congress 1st Session, June 12, 1963.

1966 *Press Reference Book, Gemini Spacecraft Number 11,* External Relations Division, McDonnell Aircraft Corporation, August 30, 1966.

NASA Publications

1964 *Astronautics and Aeronautics, 1963. Chronology on Science, Technology and Policy,* NASA SP-4004.
1965 *Astronautics and Aeronautics, 1964. Chronology on Science, Technology and Policy,* NASA SP-4005.
1966 *Astronautics and Aeronautics, 1965. Chronology on Science, Technology and Policy,* NASA SP-4006.
1967 *Astronautics and Aeronautics, 1966. Chronology on Science, Technology and Policy,* NASA SP-4007.

Other Books

1981 *The History of Manned Spaceflight*, David Baker, PhD, New Cavendish Books.
1992 *Men and Women of Space,* Douglas B. Hawthorne, Univelt.
1994 *Deke! U.S. Manned Space: From Mercury to the Shuttle,* Donald K. 'Deke' Slayton with Michael Cassutt.
1999 *Who's Who in Space, the International Space Station Edition,* Michael Cassutt, Macmillan.
2000 *Failure is not an Option,* Gene Kranz, Simon & Schuster.
Disasters and Accidents in Manned Spaceflight, David J. Shayler, Springer-Praxis.
2001 *Flight, My Life in Mission Control,* Christopher C. Kraft, Plume.
Tracking Apollo to the Moon, Hamish Lindsay, Springer-Verlag.
2003 *Fallen Astronauts, Heroes Who Died Reaching for the Moon,* Colin Burgess and Kate Doolan, with Bert Vis, University of Nebraska Press.
2007 *Praxis Manned Spaceflight Log, 1961-2006,* Tim Furniss, David J. Shayler with Michael D. Shayler, Springer-Praxis.
2007 *In the Shadow of the Moon, A Challenging Journey to Tranquility, 1965-1969,* Francis French and Colin Burgess.
2009 *Escaping the Bonds of Earth, The Fifties and the Sixties*, *A History of Human Space Exploration*, Ben Evans.
2010 *Splashdown. NASA, the Navy and Space Flight Recovery*, Don Blair, Turner Publishing Company.
2012 *U.S. Spacesuits (2nd Edition),* Kenneth S. Thomas and Harold J. McMann, Springer-Praxis.
2013 *Moon Bound, Choosing and Preparing NASA's Lunar Astronauts,* Colin Burgess, Springer-Praxis.
2014 *Liberty Bell 7, The Suborbital Mercury Flight of Virgil I. Grissom,* Colin Burgess, Springer-Praxis.

2015 *Go, Flight! The Unsung Heroes of Mission Control, 1965-1992* Rick Houston and Milt Heflin, Nebraska University Press.
2016 *The Birth of NASA, The Work of the Space Task Group, America's First True Space Pioneers,* Manfred 'Dutch' von Ehrenfried, Springer-Praxis.

About the Author

Spaceflight historian **David J. Shayler**, F.B.I.S. (Fellow of the British Interplanetary Society or – as Dave likes to call it – Future Briton In Space!), was born in England in 1955. His lifelong interest in space exploration began by drawing rockets aged 5, but it was not until the launch of Apollo 8 to the Moon in December 1968 that his interest in human space exploration became a passion. He fondly recalls staying up all night with his grandfather to watch the Apollo 11 moonwalk. Dave joined the British Interplanetary Society as a Member in January 1976, becoming an Associate Fellow in 1983 and Fellow in 1984. He was elected to the Council of the BIS in 2013. His first articles were published by the British Interplanetary Society in the late 1970s and in 1982, he created Astro Info Service (www.astroinfoservice.co.uk) to focus his research efforts.

Dave's first book was published in 1987 and has been followed by more than 20 other titles, featuring works on both the American and Russian space programs, the topics of spacewalking, women in space and the human exploration of Mars. Dave's authorized biography of Skylab 4 astronaut Jerry Carr was published in 2008. In 1989, Dave applied as a cosmonaut candidate for the U.K. Project Juno program in cooperation with the Soviet Union (now Russia). The mission was to spend seven days in space aboard the space station Mir. Dave did not reach the final selection but progressed further than he expected. The mission was flown by Helen Sharman in May 1991.

In support of his research, Dave has visited NASA field centers in Houston and Florida in the United States and the Yuri Gagarin Cosmonaut Training Center in Russia. During these trips, Dave was able to conduct in-depth research, interview many space explorers and workers, tour training facilities and handle real space hardware. He also gained a valuable insight into the activities of a space explorer and the realities of not only flying and living in space, but also what goes into preparing for a mission and planning future programs.

Dave is a friend of many former astronauts and cosmonauts, some of whom have accompanied him on visits to schools across the U.K. For over 30 years, Dave has delivered space-themed presentations and workshops to children and social groups across the U.K. This program is intended to help the younger generation develop an interest in science and technology and the world around them, in addition to informing the general

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public and interested individuals about the history and development of human space exploration.

Dave lives in the West Midlands region of the U.K. and enjoys spending time with his wife Bel and their young and very large white German Shepherd called Shado, as well as indulging in his love of cooking, fine wines and classical music. His other interests are in reading, especially military history, specifically about the Napoleonic Wars, visiting historical sites and landmarks and following Formula 1 motor racing.

Other Works by the Author

Other Space Exploration Books by David J. Shayler

Challenger Fact File (1987), ISBN 0-86101-272-0
Apollo 11 Moon Landing (1989), ISBN 0-7110-1844-8
Exploring Space (1994), ISBN 0-600-58199-3
All About Space (1999), ISBN 0-7497-4005-X
Around the World in 84 Days: The Authorized Biography of Skylab Astronaut Jerry Carr (2008), ISBN 9781-894959-40-7

With Harry Siepmann

NASA Space Shuttle (1987), ISBN 0-7110-1681-X

Other Books by David J. Shayler in this Series

Disasters and Accidents in Manned Spaceflight (2000), ISBN 1-85233-225-5
Skylab: America's Space Station (2001), ISBN 1-85233-407-X
Gemini: Steps to the Moon (2001), ISBN 1-85233-405-3
Apollo: The Lost and Forgotten Missions (2002), ISBN 1-85233-575-0
Walking in Space (2004), ISBN 1-85233-710-9
Space Rescue (2007), ISBN 978-0-387-69905-9
Linking the Space Shuttle and Space Stations: Early Docking Technologies from Concept to Implementation (2017), ISBN 978-3-319-49768-6
Assembling and Supplying the ISS: The Space Shuttle Fulfills Its Mission (2017), ISBN 978-3-319-40441-7
Gemini 4: An Astronaut Ventures into the Void (2018) ISBN: In preparation

D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9

With Colin Burgess:

NASA Scientist Astronauts (2006), ISBN 0-387-21897-1
The Last of NASA's Original Pilot Astronauts: Exploring the Space Frontier in the Late Sixties (2017), ISBN 978-3-319-51012-5

With Rex Hall M.B.E.

The Rocket Men (2001), ISBN 1-85233-391-X
Soyuz: A Universal Spacecraft (2003), ISBN 1-85233-657-9

With Rex Hall M.B.E. and Bert Vis

Russia's Cosmonauts (2005), ISBN 0-38721-894-7

With David M. Harland

Hubble Space Telescope: From Concept to Success (2016) ISBN 978-1-4939-2826-2
Enhancing Hubble's Vision: Service Missions That Expanded Our View of the Universe (2016) ISBN 978-3-319-22643-9

With Ian Moule

Women in Space: Following Valentina (2005), ISBN 1-85233-744-3

Other Books by David J. Shayler and Michael D. Shayler in this Series

Manned Spaceflight Log II – 2006-2012 (2013), ISBN 978-1-4614-4576-0

With Andrew Salmon

Marswalk One: First Steps on a New Planet (2005), ISBN 1-85233-792-3

With Tim Furniss

Praxis Manned Spaceflight Log: 1961–2006 (2007), ISBN 0-387-34175-7

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D. J. Shayler, *Gemini Flies!*, Springer Praxis Books,
https://doi.org/10.1007/978-3-319-68142-9