How Management Programs Can Improve Performance

Selecting and Implementing the Best Program for Your Organization

By Richard E. Crandall and William "Rick" Crandall

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Information Age Publishing, Inc.
Charlotte, North Carolina • www.infoagepub.com

Library of Congress Cataloging-in-Publication Data

Crandall, Richard E., 1930-
How management programs can improve performance : selecting and implementing the best program for your organization / by Richard E. Crandall and William "Rick" Crandall.
pages cm
ISBN 978-1-62396-979-0 (paperback) — ISBN 978-1-62396-980-6 (hardcover) — ISBN 978-1-62396-981-3 (ebook) 1. Industrial management. 2. Reengineering (Management) 3. Performance. I. Crandall, William, 1956- II. Title.
HD31.2.C73 2015
658—dc23
2015001562

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Printed in the United States of America

Dedication

To Jean—Yesterday, Today, Tomorrow.

To Sue—My wife and best friend forever.

CONTENTS

PREFACE

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization

Does your organization need to improve in order to remain competitive? Whether it's reducing costs, improving quality, delivering goods and services faster, or providing customized products and services, all organizations find themselves in a continuing struggle to improve the way they do things.

This book is about improvement programs. Over the last half-century, a number of programs have been developed to help organizations improve some facet of their operation. In this book, we provide a brief description of over 50 improvement programs, most identified with a three-letter acronym (TLA), and classify these programs into groups that address a variety of improvement categories. These categories include:

- Planning
- Execution
- Cost reduction
- Quality improvement
- Performance measurement
- Response time reduction
- Flexibility and agility
- Information technology (IT) and communications

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- Integration
- General management

While we have assigned each program into a specific category, most improvement programs have more than one objective and could be listed in multiple categories.

In our program descriptions, we have used a consistent format, using the following major sections:

- Name and brief description of the program
- Objectives of program (Reason for adopting)
- History (Time line, reasons originated, principal developers)
- Expected benefits
- Barriers to acceptance
- Implementation approach
- Future possibilities
- References.

Some programs may have expanded sections within each of the major sections.

While we would encourage you to read about all of the programs, we also recognize you may want to focus on certain programs that you believe would be of greatest benefit to your organization. In that case, you can use the book more as a reference. Please note that the references at the end of the program offer additional sources to explore if you want to learn more about that particular program.

We hope you find this book of value. Please contact us if you have questions or suggestions.

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ACKNOWLEDGMENTS

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization

We would like to thank a number of people for helping us to conceive of and then write this book. We became interested in management improvement programs early in our academic careers. As a point of reference, both of us (father and son) were awarded our PhDs the same year—1993, after both spending our first careers in industry. Our first paper on management improvement programs was written in 2004 for the Southeast Institute for Operations Research and the Management Sciences (SEINFORMS) Conference, "An Analysis of the Popularity of Management Programs: A Look at Publication Life Cycles." Since then, we have been fascinated by the variety and scope of the programs, most tagged with an acronym to make it easier to refer to them. Since most of the acronyms were three letters, it was not long before another acronym, TLA, for three-letter acronym, came into use. Presenting papers at conferences made it possible to receive feedback from those attending and helped us gain greater insights into the role of management programs in organizational improvement. Thanks to all of our colleagues for their help.

We are especially grateful to Jennifer Proctor, editor in chief, and Elizabeth Rennie, managing editor, of the *APICS Magazine*. With their permission, we drew heavily from the following Relevant Research columns written by Dick.

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Thanks, Jennifer and Elizabeth, for your help and encouragement.

We would like to thank all of the companies we worked for during our time in industry prior to joining the academic ranks. Dick spent over 25 years in industry working for manufacturing companies in electronic industries, service companies in wholesale and retail, and an international consulting company, where he worked with a variety of manufacturing and service companies. Rick spent over 10 years in the food service industry, most of which was with ARAMARK in contract food services. Both of us worked in implementing management improvement programs, even some of the programs described in this book.

To supplement our own experience, we dug deeply into some of the extensive research by practitioners, consultants, and academics. We reviewed hundreds of articles and books to uncover the concepts, principles, and techniques that we have included in this book. We hope the information in this book will be helpful to you in your business career.

Writing this book has been a lengthy process and has taken longer than we initially expected. During that time, George F. Johnson, president and

publisher at Information Age Publishing (IAP), has been patient and understanding. We have also enjoyed working with Amanda Uriarte in making sure we did all the things necessary to send her a reasonably complete book for publication. She understands that authors are not necessarily very good editors; however, she helped us through the final phases of that process.

Finally, as with all of our books, we want to thank Jean, wife of Dick and mother of Rick, for her tireless efforts in reading all of the pages in this book, some of them multiple times. She has been great at spotting errors and vague or illogical descriptions. Through it all, she has been positive and supportive.

Richard E. Crandall and William "Rick" Crandall

CHAPTER 1

INTRODUCTION TO MANAGEMENT IMPROVEMENT PROGRAMS

This is a book about management improvement programs. Most of us want to improve and, if you are a manager, the need to improve is a part of your daily lives. But how can "programs" help? You've probably heard of JIT. How about TQM? You may remember these terms from business school, or perhaps your company uses some form of these programs. But how about lean manufacturing, or Six Sigma? Actually, these two programs are later versions of JIT and TQM. JIT (just-in-time management) evolved into what is known today as lean manufacturing. TQM (total quality management) has evolved into a more disciplined program—Six Sigma.

How about programs such as KM (knowledge management), QRS (quick response systems) or SRM (supplier relationship management)? Are you familiar with these programs? Do you know what purpose they serve in running your organization more effectively? No doubt, you have heard a lot of the management jargon over the years, and you might even be aware of what some of these programs do. However, if you are like many managers, you simply do not have enough time to keep up with all of the latest terms and acronyms out there. You want to be up to date, but the day-to-day requirements of your current position do not afford you the luxury of taking part in the latest executive seminars on the current trends in management improvement programs. What's worse, you may

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not be familiar with programs that could help you do your job better. If that is the case, this book is about what management improvement programs are and how they can help you, as a manager. We will examine three questions in this first chapter:

1. What are management improvement programs?
2. Why are management improvement programs important to you?
3. How do management improvement programs relate to business operations?

By addressing these questions, we hope to provide you with a better understanding of how these programs can meet your companies' needs.

WHAT ARE MANAGEMENT IMPROVEMENT PROGRAMS?

As the name implies, management improvement programs are designed to improve some aspect of business operations. For example, most companies are concerned about providing their product or service to the customer in a reasonable amount of time and company management may sense that they could improve in this aspect of running their business. To address this need for improvement, management may decide to implement a special program to help them accomplish this goal. Such a program could be called QRS or quick response system. Hence, a special program now exists to improve this aspect of the business by introducing a management improvement program.

Management improvement programs are usually assigned a name to distinguish them from the normal operations of a business. Often they are known by an acronym, such as ERP (enterprise resource planning), WMS (warehouse management systems), or APS (advanced planning and scheduling). Such acronyms are useful because they help us remember the name, and purpose, of the program, In normal conversation and writing, it is easier to use letter abbreviations when making multiple references to the same program. Acronyms have become a popular way of referring to contemporary programs.

Beyond the acronyms though, it is important to remember that management improvement programs are concentrated efforts to improve some aspect of business operations. Examples of potential improvement areas include reducing costs, improving product quality, or shortening response time to the customer. They may involve a part or all of an organization. Usually, they are of a project nature, with a beginning, a life cycle, and an end. Table 1.1 displays a list of these programs and the area where they can offer improvement.

Table 1.1. A list of Management Improvement Programs

Management Programs by Potential Area of Improvement

Planning and control programs	**Response time reduction programs**
1. Materials requirements planning (MRP)	24. Quick response system (QRS)
2. Manufacturing resources planning (MRP II)	25. Efficient consumer response (ECR)
3. Enterprise resources planning (ERP)	26. Vendor managed inventory (VMI)
4. Project Management (PM)	27. Collaborative planning forecasting and replenishment (CPFR)
Execution programs	**Flexibility improvement programs**
5. Computer-integrated manufacturing (CIM)	28. Flexible manufacturing
6. Warehouse management system (WMS)	29. Agile manufacturing
7. Manufacturing execution system (MES)	30. Mass customization
8. Advanced planning and scheduling (APS)	**IT and Communications programs**
9. Theory of Constraints (TOC)	31. Electronic data interchange (EDI)
	32. Business-to-business (B2B)
	33. Business-to-consumer (B2C)
Cost and waste reduction programs	34. Automatic identification system (AIS)
10. Just-in-Time (JIT)	35. Decision support system (DSS)
11. Lean production or manufacturing	36. Interorganizational system (IOS)
12. Business process reengineering (BPR)	37. Service-oriented Architecture (SOA)
13. Business process outsourcing (BPO)	38. Software as a service (SaaS), Cloud computing
14. Value analysis	
Quality improvement programs	**Integration programs**
15. Statistical process control (SPC)	39. New Product Development (NPD)
16. Total quality control (TQC)	40. Sales and operations planning (S&OP)
17. Total quality management (TQM)	41. Supply chain management (SCM)
18. Quality function deployment (QFD)	42. Customer relationship management (CRM)
19. Six Sigma	43. Supplier relationship management (SRM)
Performance measurement	44. Product lifecycle management (PLM)
20. Activity based costing (ABC)	
21. Activity based management (ABM)	**Management Programs**
22. Balanced scorecard (BSC)	45. Management by Objectives (MBO)
23. Key Performance Indicators (KPI)	46. Strategic Management
	47. Knowledge Management (KM)
	48. Risk management
	49. Virtual organizations
	50. Chaos Theory

Sometimes, a program may originate in a particular company. For example, Japanese automaker Toyota started an improvement program to reduce inventory and improve cash flow by revamping their production system. This program was first known as the Toyota Production System (TPS) and then by a variety of other names, such as stockless production and zero inventories. Later, this program achieved widespread acceptance and eventually became known as the now famous, Just-in-Time (JIT) system.

In most cases, a management improvement program is an adaptation of an existing program that has become popular, or at least reasonably successful in other companies. As a result, most programs begin small and address a specific need. If successful, they usually expand into a much broader program to the point that it becomes embedded into the day-to-day operations of the company. In other words, it becomes a management practice that is part of the way things are done on a regular basis, not just a special program.

WHY ARE MANAGEMENT PROGRAMS IMPORTANT TO YOU?

At this point, it is important to understand that management improvement programs have been widely successful in a number of companies and throughout a vast array of industries. However, as we describe later in this book, not all implementations of these programs have been successful in every company. Implementing a management improvement program takes some "strategy", a commitment of resources, and perseverance to complete successfully. This does not mean every program is needed in your company; perhaps only certain types of programs are necessary to improve your business operations. We hope this book will help you identify which programs may be most useful to your company.

Let's take a look at how a management improvement program fits into the general scheme of things. If you think about your regular activities, you will find that most of your time as a manager deals with addressing three types of activities: (1) maintaining the smooth flow of normal day-to-day operations; (2) correcting problems that arise when these day-to-day operations run awry; and (3) making improvements in these operations (when time permits). Figure 1.1 illustrates these activities. Sustaining, or day-to-day operations inevitably have problems. Some are minor and can be easily corrected; others may be more serious and require careful handling to avoid disasters. Problem-solving can lead to ideas for improvement, an interesting concept to be discussed later.

The first set of activities is probably where you spend the bulk of your time; as a manager, the smooth running of your department, plant, unit, or organization is your responsibility. It is rare that your daily activities will run smoothly for very long. Problems arise as a natural outcome of even normal operations, although, in today's dynamic environment, it is increasingly difficult to know what is "normal." At this point, your attention is turned to addressing the problem at hand. Since you are a good

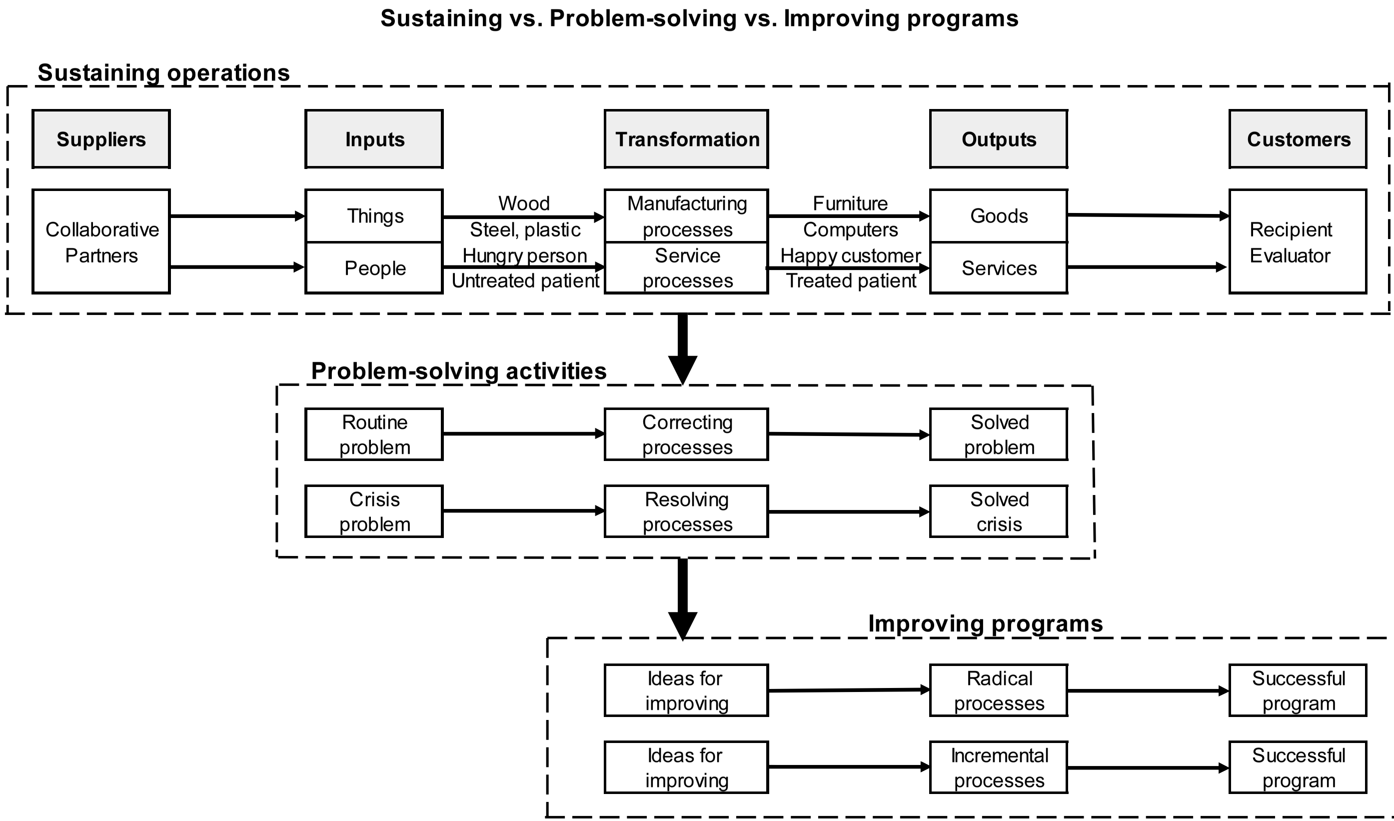

Figure 1.1. Types of management activities.

manager, the day-to-day operations will continue because you have set up a good system. However, your attention must now be turned to remedying the situation that has disrupted your day. It is this second set of activities describe above that can make your day a challenging experience. Examples of such problems abound, and they are usually unique to a given organization or industry. In a retail setting at the store level, your attention may be directed towards the following:

- Setting up a contractor to fix the leaking roof
- Assisting a customer who has slipped on the floor
- Filling in for an employee who has called in sick
- Calming down an irate customer who has returned some defective merchandise
- Evacuating the store of customers when the power goes off.

However, if you are in mid-management, your set of problems may be much different. Your normal day-to-day operations may be affected by the following:

- Finding someone to operate a store when the manager must be hospitalized for some medical need
- Re-scheduling a company sales promotion when a major supplier is unable to fulfill its delivery due to adverse weather conditions
- Coordinating efforts to get a store up and running after a fire has damaged part of the storage area
- Getting a cell phone call in the middle of the night and finding out the company CEO has just died of a heart attack
- Addressing a major supplier who must raise prices in the middle of a contract due to the cost of escalating oil prices.

Maybe you are in the manufacturing sector. While some of the items may apply to you, other areas that can disrupt you normal activities may include:

- Trying to maintain production when a major piece of machinery goes down
- Informing a major customer that you must raise the price of your product due to an unforeseen increase in component costs
- Addressing the cause of an employee injury on the manufacturing line
- Finding out the cause of a product defect

- Handling an employee grievance that has just been filed by the shop steward.

Regardless of your managerial level, or the industry you operate in, there is no doubt that problems like these can take a great deal of time to resolve. Between the activities described in the first and second category above, you may find that your days are full, with little time left over for reflection on how to actually improve business activities.

How beneficial it would be to actually have time to reflect on ways to improve operations so some of those items described above would not occur in the first place. And yet, this is the essence of the third category of activities, to actually improve managerial operations. There is an irony in this discussion that almost sounds like a mathematical equation; the problems that occur in the second category, within the context of the first category (normal day-to-day operations) can be addressed by solutions from the third category (management improvement programs). Or, let's look at it this way:

Normal day-to-day operations + problems = the need for management improvement programs

The left side of the equation indicates that your day consists of daily operations, plus an abundance of problems thrown in. Although it is common to think of these problems as being mostly negative events, they can also be an opportunity for learning and making changes in your organization (Wang, 2008). The right side of the equation shows the need to be on the lookout for ways to improve things, hence, the need for management improvement programs. As a manager, it is not enough to simply be operating on the "left side;" you need to be on the "right side" as well. This book will offer some ideas about how to achieve this balance.

HOW DO MANAGEMENT IMPROVEMENT PROGRAMS RELATE TO BUSINESS OPERATIONS?

Where do management programs fit in with running a business? Take a look at Table 1.2, which shows the three parts of our equation, normal day-to-day operations, problems, and the need for management improvement programs. In Table 1.2, we assume a business lies within the framework of a supply chain. Every business is embedded into a number of supply chains, both in transforming goods and providing services, as well as being a supplier to other businesses. To understand the complexity of business operations today, one must see this inter-connectivity of activities. Each of the five facets of the supply chain includes elements of day-to-day operations, problems, and management improvement programs.

Table 10.2. How Management Improvement Programs Relate to Business Operations

Normal Day-to-Day Operations Focus on the Supply Chain	*Problems That Arise From Day-to-Day Operations*	*Potential Management Improvement Programs*
Suppliers Provide raw materials for production	• Supplier relations are strained • Poor coordination between the company and its suppliers • Missed orders, late deliveries, price fluctuations, poor quality of delivered products	• Supplier relationship management (SRM)
Inputs Inventory from suppliers becomes inputs for production	• Inventory shrinkage occurs • Too much or too little inventory is on hand	• Enterprise Resource Planning (ERP) • Warehouse management system (WMS)
Transformation Product is manufactured	• Production costs are excessive • Excessive work-in-process inventory is present • Production process is slow	• JIT • Lean production
Outputs Products and services are now available to the customer	• Product defects are present • Customer wants more features than your company is offering	• Total Quality Management • Six Sigma • Mass customization • Agile manufacturing
Customers Customers consume the product or service	• Customer complaints about late deliveries • Inability to build long-term relations with the customer	• Quick response system (QRS) • Efficient consumer response (ECR) • Customer relationship management (CRM)

Suppliers

Suppliers provide raw materials for the production process; we have listed their inputs as a separate step in the supply chain. The supplier represents an ongoing, living relationship with your company. We want to stress the word relationship because when this relationship is strained, business transactions between your supplier and your company will also be strained. Such a strain leads to the general problem of poor coordination activities between your company and your supplier, as depicted in the middle column of the table. The result can be missed orders, late deliveries, price fluctuations that are harder to predict, and perhaps even poor quality of products that are delivered from your supplier

Note that in Table 1.2, the far left column and the middle column represent the left side of the equation discussed above. Note also that the far right column represents the other side of the equation, the potential need for management improvement programs. Fortunately, in the case of poor supplier relationships, there is a set of interventions that come under the category of management improvement programs called supplier relationship management (SRM). The goal of this management improvement program, as the name implies, is to improve long-term relationships with a company's suppliers.

Inputs

When your company receives supplies, it must store those supplies somewhere. In your normal day-to-day operations, storage can be temporary when supplies are always available and not accumulating to any great degree where they can become damaged or spoiled. However, a number of problems can occur to your inventory. Depending on how your inventory storage is set up, you may have too little inventory, or too much. Of course, too little inventory can cause delays in production and dissatisfied customers. Too much inventory can raise your storage costs, which ties up money that could be used somewhere else in running your company.

Fortunately, there are management improvement programs that can address these very problems. Warehouse management systems (WMS) seek to address issues that arise when moving goods into and out of storage. These programs also include the use of technology, both physical and software, to help develop the optimum methods of controlling inventory once it is in-house.

Transformation

In the transformation process, your company is actually making the product, or providing the service. In addition, many companies today are realizing that they are BOTH a manufacturer and a service provider, a phenomenon we like to call the vanishing boundary between service and manufacturing (Crandall & Crandall, 2014). For example, manufacturers not only make a product, but they must provide aftermarket service for their customers, as in the case of computer hardware and software or airplane engines.

The transformation process can be plagued with a number of problems including rising production costs, excessive work-in-process inventory, and slow manufacturing cycles. Once again, there are management improvement programs which can systematically address these problems. JIT and its follower, lean manufacturing, are programs that address these types of production issues.

Outputs

Outputs are the actual products or services that your company provides. Usually, we think of outputs as being a tangible good that is placed in the hands of the customer. Typical problems that arise with outputs tend to be quality related—a product has a defect, or it does not perform as well as the customer would like. A number of management improvement programs exist to address quality issues, including statistical process control (SPC), total quality management (TQM), quality function deployment (QFD), and Six Sigma.

A secondary set of problems relates to the usability of the product in relation to its features. In this scenario, there is nothing wrong with the product in terms of quality, but the features do not match what the customer desires. This is problematic to manufacturers who want long stable production runs in order to keep costs down. However, the demands of the customer dictate that a number of products be built, often with common platforms (such as an automobile), but with small lots of product with different features (or bells and whistles as they like to say in the automobile industry). Two management programs address this dilemma—agile manufacturing and mass customization. The goal of these programs are to help management set up manufacturing systems that can address the various needs of customers, while maintaining some semblance of mass production.

Customers

Ultimately, the product or service a company produces must be delivered into the hands of the customer. A common problem at this point is to deliver the goods in a timely manner. It is not enough for a company to produce a high quality product at a decent price; the delivery of that product must be done expediently. This time-based competition can put a company at a competitive disadvantage if it is not able to perform up to the expectations of its customers. Fortunately, there are management improvement programs that address this very problem—quick response systems (QRS) and efficient consumer response (ECR).

There is another area of consumer relations that should be mentioned. Some businesses view their customers as not just casual sources of income in terms of their purchasing, but as potential long-term partners. An abundance of consumer information is available to the company by cultivating these ongoing relations with their customers. Not surprisingly, a systemized management improvement program is available to help facilitate these relationships, customer relationship management (CRM).

Supply chain participants need a way to communicate with, and establish continuing relationships with, other members of the supply chain. There are a number of information technology related programs that make this possible. They include interorganizational systems (IOS), automatic identification systems (AIS) and electronic data interchange (EDI).

By looking at the supply chain, we can quickly see applications of management improvement programs. You might have noticed that some of these programs overlap several areas of the supply chain. Indeed, most programs follow a wider scope than what has been illustrated in Table 1.2. For example, JIT and its successor, lean production, have an influence on almost EVERY area of the supply chain, not just the transformation function. Nonetheless, we offer this introductory framework to show where these management programs are most likely to be used.

WHERE DO WE GO FROM HERE?

This book will provide you with a comprehensive description of the most popular management improvement programs and their primary applications to your organization. We will discuss the philosophy and principles of these programs and include a discussion on how to use each program to achieve optimum success. A central theme of this book is to not just adopt an improvement program for the sake of adopting it, but to match the improvement program with the specific needs in your organization. In the chapters that follow, we will illustrate how this matching process can be conducted. Above all, we plan the book to be a concise and useful resource to both practitioners and academics. Here is what you can expect in the chapters that follow.

Chapter 2 describes the history of management improvement programs. While the history of such programs may not sound relevant in a book like this; it is helpful to understand this facet of improvement programs so you can make the best selection for your organization. Reading this chapter will show that using a project management approach will increase the likelihood of success in your efforts. This chapter will introduce the systems theory concept as a method for designing a management program to fit your organization's need.

Chapter 3 will organize the management improvement programs into groups with common objectives. Although most management programs have multiple secondary objectives, they usually have one primary objective. This background information is necessary to determine the full range of applicability for your proposed program.

Chapters 4 through 13 will describe 50 management improvement programs in a comprehensive format that makes comparisons among the different programs possible. The descriptions in these chapters will serve as a reference source about the various programs that are available for your use. Figure 1.2 shows these programs on a time line indicating their approximate time of origin. The chapters are arranged as follows:

- Chapter 4—Planning programs
- Chapter 5—Execution programs
- Chapter 6—Cost reduction programs
- Chapter 7—Quality programs
- Chapter 8—Measurement programs
- Chapter 9—Quick response programs
- Chapter 10—Flexibility and agility programs
- Chapter 11—Information technology and communications programs
- Chapter 12—Integration programs
- Chapter 13—Management programs

Chapter 14 will describe how you can select the program best suited for your organization's needs. In this chapter, we stress that programs should be selected not because of their popularity, but because there is an actual need in your organization that must be met.

Chapter 15 describes an approach to successfully implementing a management improvement program. It is in the implementation that the true value of a program can be either realized, or lost.

Chapter 16 describes the anticipated future of management improvement programs. While management programs will always exist, they will certainly change as the business environment changes. In addition, programs that are in existence today may eventually become assimilated into the day-to-day operations of the company. Likewise, newer programs will emerge to address emerging problems in the operations of the company.

CONCLUDING COMMENT

Management improvement programs are here to stay. They are needed because of their unique ability to address specific types of problems in an

Program Groups	Time Line (Approximate Origin of Program)							
	1975	1980	1985	1990	1995	2000	2005	2010
Planning	MRP		MRP II		ERP		PM	
Execution		CIM		MES	WMS	APS	TOC	
Cost Reduction	VA		JIT	BPR			Lean	BPO
Quality		TQC	SPC	TQM		Six Sigma	QFD	
Measurement				ABC	ABM	BSC	KPI	
Response Time			QRS	ECR		CPFR	VMI	
Flexibility			Flexibility		Mass Cust	Agile		
Communications		DSS		EDI, IOS	AIS	B2B, B2C	SOA	SaaS, Cloud
Integration			NPD	S&OP	SCM	CRM,SRM	SCM Exp.	PLM
Management	MBO		Strategic		Virtual	KM	Risk	Chaos
	1975	1980	1985	1990	1995	2000	2005	2010

Figure 1.2. Classification of management programs with an approximate time line.

organization. Some knowledge of their background and uses will help in understanding their benefits and risks. We hope this book will help you in selecting and implementing a program that will be useful in your organization.

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CHAPTER 2

HISTORY OF MANAGEMENT IMPROVEMENT PROGRAMS

To say that management history is exciting may sound like a misnomer. However, what makes this field interesting are the pioneers that emerge. People like Charles Babbage, Frederick Taylor, Frank and Lillian Gilbreth, and Elton Mayo all made significant contributions to the body of knowledge. They also laid the groundwork for the onset of management improvement programs.

In this chapter, we will take a brief look at how management improvement programs evolved. We will also look at the life cycle of these programs. Understanding the life cycle is important because it will help you better select those programs that are applicable to your organization. Let's begin with a little history.

HOW MANAGEMENT IMPROVEMENT PROGRAMS EVOLVED

To understand the evolution of management improvement programs, it is necessary to catch a brief glimpse of management history. Table 2.1 will serve as our basis of the following discussion. According to management historian, Daniel Wren (1987), management history can be divided into four segments of time: early management (the pre-scientific period), the scientific management era, the social man era, and the modern era. Each of these is discussed briefly below and how they eventually led to the onset of management improvement programs.

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Table 2.1. Management Eras and the Onset of Management Improvement Programs

Management Era	*Key Ideas During the Era*
Prescientific Period (1770s-1880s)	• The Industrial Revolution starts in England and eventually spreads to the United States • The field of management develops as large groups of employees are working in the same factory, which results in larger than ever organizations
Scientific Management Era (1880s - present)	• Scientific Management develops—seeking to find the one best way to do things, particularly in the area of manufacturing and trades such as bricklaying • Administrative Management develops—putting structure and organization into the organization
The Social Man Era (1920s - present)	• The Human Relations Management movement begins • New ways to design jobs and motivate employees becomes important
The Modern Era (1960s - present)	• The field of management science develops • Systems theory attempts to reconcile the various approaches to management • Contingency theory seeks to adapt management practices to the individual organization • Management Improvement Programs emerge. These programs utilize systems and contingency theory to solve problems in the management sciences

Note: These management eras are developed from the framework by Wren and Bedeian, (2008).

Early Management Thought (Prescientific Period: 1776 to 1886)

Early management thought dominates the period up to the Scientific Management period. The period from 1776 to 1886 marked the introduction of large-scale manufacturing to the industrial landscape. When considering management improvement programs, the time period during the Industrial Revolution is especially important, as this era marked the transition from a craft/agricultural economy to one based on large factories. The industrial revolution started in England, and later carried over to other parts of Europe and the United States.

The transition to factory life meant that new ideas had to be developed on how to manage these larger facilities. For the first time in modern history, large groups of employees were now working under one roof. This transition meant that manufacturing processes needed to be standardized and speeded up as well. It is this need that marks the origins of modern management improvement programs, as all programs focus on the need to improve some aspect of the management process.

A number of interesting personalities emerged on the scene during the pre-scientific management era. Among our favorites is Charles Babbage, the father of modern computing. He was also considered "the irascible genius" (Wren, 1987, p. 58), due mainly, to his eccentric nature. Babbage laid the groundwork for the field of management science. He invented a crude computer, a device he called the "analytical engine", which performed functions that mimicked today's modern computers. His eccentric nature and genius were known to many, as observers noted he blew bugles at the local organ grinders to scare them off, a distraction that upset his intense concentration (Wren, 1987). So distraught was Babbage over this situation that he claimed that one-fourth of his working power had been destroyed over a 12 year period (Stigler, 1991).

We mention the early management thought period because this was the period where large factories began. It is within this context that most modern management improvement programs also began, in the manufacturing sector. As we will see though, the large factories created three major problems—inefficiency, exploitation of the workers, and environmental damage. The scientific management era, discussed next, addressed the inefficiency problem.

The Scientific Management Era

The scientific management era was characterized by a need to find standardized processes in the area of manufacturing. Frederick W. Taylor (1856–1915) is often referred to as the father of scientific management because of his research in work methods studies. His approach was based on the idea that any job can be improved by breaking it down into its basic elements. From there, it was a matter of examining each of the job elements and then finding ways to improve the job. In essence, scientific management was one of the first management improvement programs.

At times, Taylor's work may have seemed a bit eccentric. Imagine doing a study on shoveling. That is correct, using a shovel to move a mass of something, like dirt or gravel. Taylor actually conducted such a study and even wrote about it in his paper, *The Principles of Scientific Management.* In his paper, he describes the study of observing two men shoveling "something", and then determining the ideal weight the shovel should hold in order for the men to perform the most amount of work. Taylor's own account of the process follows:

> We started in at a pile of material, with a very large shovel. We kept innumerable, accurate records of all kinds, some of them useless. Thirty or forty different items were carefully observed about the work of those two men. We counted the number of shovelfuls thrown in a day. We found with a weight of between thirty-eight and thirty nine pounds on the shovel, the man made a pile of material of a certain height. We then cut off the shovel again and with a thirty-four pound load his pile went up and he shoveled more in a day. We again cut off the shovel to thirty pounds, and the pile went up again. With twenty-six pounds on the shovel, the pile again went up, and at twenty-one and one-half pounds the men could do their best. At twenty pounds the pile went down, at eighteen it went down, and at fourteen it went down, so that they were at the peak at twenty-one and one-half pounds. There is a scientific fact. A first class shoveler ought to take twenty-one and one-half pounds on his shovel in order to work to the best possible advantage. (Taylor, 1916, p. 44)

This account illustrates the first principle of scientific management. In total, there were four principles of scientific management:

1. Scientifically study each part of the job task and develop the best method for performing those tasks. Taylor illustrates this principle by finding the best weight for the shovel to hold. However, there was more going on in the study. The workers were also being observed in terms of the time it took to complete their tasks, and the physical motions they were performing to shovel the material at hand. In essence, these were early examples of time and motion studies, an integral part of scientific management.
2. Carefully select the workers and train them to perform the task by using the scientifically developed method (from the first step above). Taylor is clear in his writings that management should not seek the cheapest labor available. Instead, efforts should be made to match the job to the worker, and to train the worker well in the correct method of doing that job.
3. Follow up with the workers on a regular basis to ensure that they use the proper techniques developed above. Taylor recommends periodic checks to make sure the workers are maintaining that proper form. An analogy with a golfer visiting their golf pro may be helpful here. For those of you that play golf, a visit to the golf pro means having him or her watch your swing to detect little imperfections that may have slipped in. Such imperfections or movements cause horrible things to happen, like a slice or a hook. The pro notes these movements, points them out to you, and then attempts to help you to correct your swing. Taylor also recommends providing monetary incentives to the workers to encourage

them to be true to the techniques they have been taught by management. Taylor was often accused of exploiting the workers, but a careful reading of his philosophies indicates the opposite. He truly wanted a win-win situation where both management and the workers were happy with each other.

4. Divide the work and responsibilities so that management is responsible for planning the work methods while the workers are responsible for actually doing the work. Here we see a hierarchy developing within the organization. One that advocates that management does the "thinking" while the workers perform the physical side of the work. One should note that what we call "participative management", where the workers' inputs are solicited, was not a part of scientific management.

Taylor's philosophy soon led to **job specialization**, a job with a narrow range of tasks that has high repeatability, resulting in greater efficiency. Jobs designed in this manner are simple, require less training than a skilled craft, and are easy to measure. Indeed, the scientific management approach made possible high-speed, low cost production that plays a great part in the standard of living we enjoy today. Conversely, job specialization carried to the extreme can have significant adverse effects on employees such as absenteeism, lack of motivation, and employee turnover. This occurs because jobs that are highly specialized can become boring and lead to a decrease in motivation.

Frank (1868-1924) and Lillian (1878–1972) Gilbreth

Frank and Lillian Gilbreth were an engineering team who together, studied methods and motion techniques. Their quest was to increase productivity through motion simplification. On a personal side, the couple was also quite productive, rearing a total of twelve children! Two of their children later wrote a book about their quirky parents, particularly their father, entitled *Cheaper by the Dozen* (Gilbreth, Jr. & Carey, 1948).

Imagine someone watching your every move while you tried to carry on your job or daily routine at home or work. That would be Frank Gilbreth. In fact, Frank once tried to shave using two razors, thinking that method would be faster than using the traditional one razor. Unfortunately, while the shaving did go faster, the bandages needed for the resulting cuts took longer to apply, thus making the whole process slower from start to finish. Frank eventually jettisoned this approach to shaving because of the overall extra time needed to complete his morning shave (Gilbreth, Jr. & Carey, 1948).

On the practical side, Frank was an accomplished bricklayer, and set out to find the one best way to lay bricks, a procedure which up to that time, had been approached in a variety of ways. By using motion studies and identifying basic movements, which he called "therbligs" (his last name spelled backwards), he developed an approach that was more efficient.

Lillian Gilbreth was one of the first women to get a doctorate in industrial psychology and was active in the study of the effects of work methods on worker attitudes about their work. She was also a world-renowned lecturer on the research that she and her husband performed.

The legacy of Frederick Taylor, the Gilbreths, and others within the Scientific Management Era was that work could be done faster. The principle was to break the job task down into its component parts, and then reassemble the work process in a more efficient manner. Scientific management found its applications primarily in the manufacturing industries. However, some applications were eventually "borrowed" into service industries, particularly fast food restaurants, as operators sought to deliver cooked food quickly to the customer, while maintaining consistency from one store to the next (Crandall & Crandall, 2007).

Administrative Management

While scientific management focused on actual work procedures, administrative management addressed the structure and management of the firm. One of the early thinkers in this area was Henri Fayol (1841–1925), a French engineer who progressed through the management ranks in the coal and iron industry during the later part of the nineteenth century and the early part of the twentieth century. Fayol believed that the managerial functions needed further study and expanded his view by identifying 14 principles of management. Table 2.2 describes these 14 principles. Keep in mind that during Fayol's time, management as a field of study had not yet been developed. Hence, the principles he described may seem obvious to the reader of this book, but during Fayol's time, these were actually new teachings.

Another pioneer in the Administrative Management theory building was Max Weber (1864–1920), a German sociologist who published his work at the end of the nineteenth century, but was largely unknown in English-speaking circles until the 1920s. He outlined the characteristics of what he called the bureaucracy, a term he used to describe an ideal, modern and efficient organization. Hence, bureaucracy was not a negative term, but a desired state of organizing. Table 2.3 describes the seven characteristics of Weber's ideal bureaucracy. Weber's bureaucracy is an

Table 2.2. Fayol's 14 Principles

1. **Division of work:** The concept of job specialization as we know it today. Fayol recognized production could be increased if work was divided into smaller parts, thus making employees more efficient.
2. **Authority:** The right of managers to give orders to the employees.
3. **Discipline** In light of the authority above, employees must respect this right of managers to give orders if the organization is to be effective.
4. **Unity of command:** Each employee should have only one boss.
5. **Unity of direction:** A group of activities with a common objective should be directed by one manager.
6. **Subordination** of individual interests to the general interest The interest of the organization is more important than the interest of the individual employee.
7. **Remuneration:** The employees need to be paid fairly for the work they provide.
8. **Centralization:** This allows for the option of employees being involved in decision making or not. The extent to which they are involved or not depends on the situation at the individual organization. The concept is similar to how we view it today, with centralization meaning the main policy decision are made at headquarters, while decentralization allows for some freedom of decision making at the field level (unit level).
9. **Scalar chain:** The lines of authority that exist in the organization. This can be seen today in the firm's organization chart. Fayol maintained that communication should follow this scalar chain, but certain exceptions could be allowed if all the involved parties agree to it ahead of time.
10. **Order:** The resources of the organization, that is, the employees, supplies, equipment, and raw materials, should be in the right place at the right time.
11. **Equity:** Managers should be kind and fair to their employees.
12. **Stability** of tenure of personnel: Efforts to keep good employees from leaving the organization should be implemented. However, in the event of their departure, procedures should be in place to ensure their expedient replacement. Note how this is the signals the beginnings of human resource management.
13. **Initiative:** Employees are encouraged to be enthusiastic about their work.
14. **Esprit de corps:** Management should seek to build harmony and a team spirit within the organization.

Source: Fayol (1949).

Table 2.3. Weber's Bureaucracy

The following 7 characteristics describe what Max Weber would say makes up the ideal bureaucracy:

1. A division of labor should exist among all jobs in which the authority and responsibility of those jobs are clearly defined.
2. Offices or positions are organized in a hierarchy of authority.
3. All employees (managers and hourly employees) should be selected on the basis of technical qualifications demonstrated by formal examination, education, or training.
4. Managers should be appointed, not elected.
5. Managers should work for a fixed salary, not an hourly wage.
6. Managers should not have ownership in the units they are managing.
7. Managers are held accountable by strict rules, discipline, and controls in terms of the performance of their jobs.

Source: Henderson and Parsons (1947).

important contribution because like Fayol, it offers a system for setting up an organization into a smooth running, efficient entity.

The scientific management era is important to note in the progression towards management improvement programs. Taylor and the Gilbreths emphasized the need to look at efficient manufacturing processes while Fayol and Weber focused on the necessity for sound organizational structure. This two-phase approach refined the inefficiencies created in the early management era, when factories were being built and the process of making durable goods on a large scale was just being started. What was missing though was the need to accommodate the welfare of the working employees, a factor that the social man era sought to address.

The Social Man Era

Elton Mayo (1880–1949) turned the lights on to the human relations movement. He was the researcher who offered an explanation to an unusual situation that occurred at the Hawthorne Plant, (a facility of Western Electric), during some experiments on lighting. The experiments took place in the late 1920s and were designed to answer this question—does illumination (i.e., the degree of lighting intensity) have an effect on worker productivity? The prevailing thinking was that it did and that the more the lights were illuminated, the higher worker productivity would become. In fact, some earlier experiments in another facility had confirmed this thinking. However, at the Hawthorne plant, something unusual occurred. As experimenters altered the illumination of the lights, worker productivity did not follow the predicted pattern (Wrege, Gill, & Mundy, 1981). In fact, productivity even went UP as the lights were turned down. In a follow up experiment, the lights were turned down to "the level of moonlight", and productivity still increased (Wren, 1987, p. 237). So how do you explain this finding?

Elton Mayo, an Australian born philosopher and logician, was called on to weigh in on the perplexing findings from the illumination experiment. He theorized that the workers improved, not because of, or in spite of the lights, but for a much deeper reason. Instead, the workers showed improvement because "someone" was paying attention to them, a phenomenon that was later termed, the Hawthorne Effect. Those paying attention to the workers were the researchers present at the plant, who were adjusting the lights, talking to the employees, and asking questions about their work. This added attention, to an otherwise boring day at work, gave the workers satisfaction and motivation, which resulted in higher productivity.

The concept of paying attention to the employees for whatever reason was intriguing at the time, as the emphasis in a factory setting was always more on the product output and smooth running machinery, rather than the feelings of the employees. Nonetheless, Mayo's influence later led to the "human relations movement", the belief that valuing workers can have some obvious benefits to the organization. Certainly, some scholars have debated the results of Mayo's findings, but his influence still holds to this day.

Job Design

Because of the adverse effects of job specialization brought about by scientific management, some researchers began to look for alternative ways to design and manage work. In the 1950s Eric Trist's studies in Great Britain's coal fields led to his theory that work has both technical elements and behavioral elements (Trist & Bamforth, 1951). This dichotomy implies that management should seek a balance between the technical and behavioral aspects when designing jobs. Analysts should study the entire work system, not just individual tasks. As a result, the concept of job design became more important.

Effective job design meant employees were motivated to do their jobs because the job was designed with specific motivational factors in mind. Researchers Richard Hackman and Greg Oldham were influential in promoting this philosophy through their job characteristics model (1975). They said there are five factors that make a job motivating, and if you increase any or all of these factors, the result will be a more motivated employee. The five factors; skill variety, task identity, task significance, autonomy, and feedback are described further in Table 2.4.

Over time, three employee-focused job design techniques evolved—job enlargement, job rotation, and job enrichment. **Job enlargement** gives an employee more tasks to perform, thereby increasing the need for more skills, which results in reduced boredom and increased job satisfaction. For example, instead of just assembling a product, the employee may also perform preventive maintenance on their work equipment.

Job rotation allows employees to exchange jobs with other employees, usually on a predetermined schedule. This practice provides some variety for the employee, enlarges their job skills, and makes the employee more valuable to the company. The benefit for management is a more highly skilled, flexible workforce. An example of job rotation involves rotating bank employees between working as tellers and as loan processors. Restaurants have long recognized the need for job rotation as a training practice for aspiring managers. Typically, managers in training will learn to

Table 2.4. Increasing Motivation Through Job Design

Here Are the Job Dimensions That Should Be Increased	*The Job Dimension can Be Increased by:*	*By Increasing the Job Dimensions, the Employee Will Experience:*	*For the Organization, Using Job Design Will Result in the Following:*
Skill variety—the amount of skills and abilities required to perform the job	Job enlargement—add more tasks to the job, particularly tasks that are combined from other aspects of the job	MORE meaningfulness of work	1. HIGH internal work motivation 2. HIGH quality of work performance 3. HIGH satisfaction with the work 4. LOW absenteeism 5. LOW employee turnover
Task identity—the degree to which a job requires doing a whole piece of work	Allow the employee to perform larger modules of work		
Task significance—the perceived importance of the job on the part of the employee	Involve the employee in a relationship with the customer		
Autonomy—the amount of freedom the employee has in determining how to carry out the job	Allow the employee some freedom in planning their work	MORE responsibility for the outcome of the work	
Feedback—the degree that performing the job provides actual feedback to the employee on how effective he/she is working	Add feedback points where the employee can see directly if they are performing their job well or not	BETTER knowledge and understanding of the actual results of the work they are doing	

Source: Adapted from Hackman, Oldham, Janson, and Purdy (1975, p. 58).

cook, wait tables, wash dishes, and perform other functions relevant to the restaurant.

Whereas job enlargement is the *horizontal* expansion of a job, **job enrichment** expands an employee's tasks *vertically* into aspects of managerial functions. Job enrichment not only expands tasks upward, but also expands responsibility. It is the most comprehensive of the humanistic approaches to job design, and embodies the three factors that Frederick Herzberg's research enhances job satisfaction: increasing **achievement**, **recognition**, and **responsibility** (Herzberg, 1987).

The Social Man Era and Management Improvement Programs

The human relations movement emphasized that employees are an important part of the firm, and their viewpoints should be respected. This becomes especially important when change efforts are underway in the company. The implementation of management improvement programs (an example of organizational change) requires that all employees, both production and management, have some degree of say in how these programs should be incorporated into the smooth running of the organization. It is a prescription for disaster when management simply mandates that a certain management improvement program is about to be implemented, without considering the viewpoints of the employees.

The Modern Era

A key development during the modern era was the arrival of the field of management science (Wren, 1987). The use of mathematical tools to solve management problems has strong ties with the field of scientific management. That management science developed should not be a surprise. Organizations were getting even larger and more complicated and sophisticated tools were needed to solve the ever increasing array of operational problems. This observation is important as most management improvement programs have strong roots in management science. Two other developments, systems theory and contingency theory were also influencing the impending arrival of management improvement programs.

Systems Theory

Systems theory was formalized in 1954 when the Society for General Systems Theory, later renamed the Society for General Systems Research, was founded under the leadership of biologist Ludwig von Bertalanffy, economist Kenneth Boulding, biomathematician Anatol Rapoport, and physiologist Ralph Gerard (Schoderbek, Schoderbek, & Kefalas, 1990). Systems theory provided a way to blend elements of the major management theories into packages, or programs. Prior to that time, most researchers and practitioners used a reductionist approach in which they broke a large problem into small parts and attempted to solve the small problems first. Once this was accomplished, the problem components were reassembled into a more workable process.

Systems theory encouraged analyzing not just the problem components, but also the relationships among those components. It has had widespread application in the medical field. For example, the development of vaccines, gene splitting, DNA analysis and organ transplants have been approached using a systems theory perspective. Applications of systems theory in science and technology include space travel, weather forecasting, and digital data transmission. Computerization has facilitated the design and implementation of systems, not only in the sciences but also in business applications. As a result, systems theory has evolved over the latter part of the twentieth century into an ever broader and more complex topic.

In the area of management, systems theory has resulted in a synthesis in terms of the application of various management theories. In the early part of the twentieth century, scientific management, administrative management, and human relations management were viewed as complete in themselves and independent of each other. Proponents tended to subscribe to one of these philosophies as a primary managerial approach to running their businesses. Applying systems thinking made it easier to select applicable elements from the different management theories to form a complete systems approach to solving managerial problems. This perspective is important to note because today's management improvement programs are based on a systems theory approach.

Contingency Theory

Scientific management advocated a "one best way" approach to approaching managerial processes and problems. Usually, this best way was the one that was the most efficient in terms of carrying out the process at hand. However, one problem with this approach is that the "one best way" may not fit the needs of all organizations. Consider these scenarios and the potential problems that could result:

- Does one style of leadership fit all types of situations? Do you want the same style of leader who does well training recruits in the Marines, using that same style to manage an R&D unit at a software firm?
- In terms of production processes, is a batch flow setup appropriate for all situations? Likewise, should the assembly line always be used? After all, it is the most efficient in most cases.
- Is a centralized, top-down approach to management appropriate in all situations? While appropriate in a military unit, should it be used in a university academic department?

Obviously, these examples are exaggerated a bit to show that one size does not fit all in terms of management. There are situations where leadership, manufacturing processes, and organizational structure need to be "adjusted" to fit the particular organizational needs.

Contingency theory made it possible to apply a concept, technique or program, in a modified format to a particular company to fit their specific needs. Contingency theory originated in the information systems area of management and has been widely extended to other management areas. For example, it supports the position that no single organizational structure—centralized, decentralized, tall, or flat—is best for all companies. Instead, the structure should be adapted to the situation. In this book, we will show that the most effective applications of management improvement programs are to design and implement them to fit the specific needs of the organization at hand.

The Modern Era and Management Improvement Programs

The modern era of management thinking builds on the previous eras. These in turn, help lay the foundation for the advent of management improvement programs. Table 2.4 identifies the influence of the scientific, administrative, and human relations movements on two management improvement programs, just-in-time (JIT) and total quality management (TQM). Note how each of the three management movements influence the two programs in different ways. This influence is an example of systems theory at work. Note also, how an emphasis is placed on adapting that program to the needs of the individual organization; an application of contingency theory. Table 2.5 also illustrates a theme throughout this book; the popular management improvement programs of today have received much of their content from earlier management theories.

Looking at the management history eras gives us a sense of how improvement programs came into practice. Another useful perspective is to look at the individual management programs in terms of their life cycles. In the next section, we discuss the life cycle of management improvement programs and why that is important for today's practicing manager.

The Life Cycle of a Management Improvement Program

Just as the field of management has a history, an individual management improvement program also has a history, or a life cycle. A product

Table 2.5. Program Concepts Derived From Management Theories (A Systems and Contingency Theory Approach)

	Just In Time (JIT)	*Total Quality Management (TQM)*
Objectives of the Management Improvement Program	• Reduce in-house inventories • Reduce supplier and customer lead times • Eliminate waste • Pursue continuous improvement • Recognize customer needs	• Reduce the cost of defects • Offer a competitive advantage based on quality • Eliminate waste • Pursue continuous improvement • Recognize customer needs
Management Theories	*Contributions to JIT*	*Contributions to TQM*
Scientific Management	• Pull method of material flow • Standardized work methods • Uniform workstation loads	• Continuous improvement • Cost-of-quality • Problem-solving process
Administrative Management	• Product focus • Close supplier ties • Group technology	• Quality as a competitive weapon • Benchmarking • Quality as customer's perception
Human Relations Management	• Flexible work force • Horizontal organization • Teams/employee empowerment	• Self-managing teams • Quality at the source • Cultural change

Source: Adapted from Crandall & Crandall (2014, p. 97).

life cycle goes through a process such as birth, growth, stability, and then decline. Management improvement programs follow a similar pattern. We will see in a moment that successful programs ideally do not go into decline; they become part of the day-to-day running of the firm. In other words, the process of the program is no longer new, it is assimilated into the management philosophy of the firm.

How do we know that management improvement programs have a life cycle? Actually, in two ways. First is the common observation that some programs work, and some don't. However, this way is not very scientific. There is another method that is more accurate, but it relies on an indirect approach to tracking a program life cycle—bibilometric data. This term is a reference to how many articles have been published about a certain management improvement program. If you plot the number of articles written exclusively about a single management program by the years the articles were published, the result is a curve on a graph. Figure 2.1 shows such a plot for JIT and lean manufacturing.

Most research indicates a bell shape curve as the most common life cycle form (Abrahamson, 1996: Spell, 2001). Intuitively, this certainly

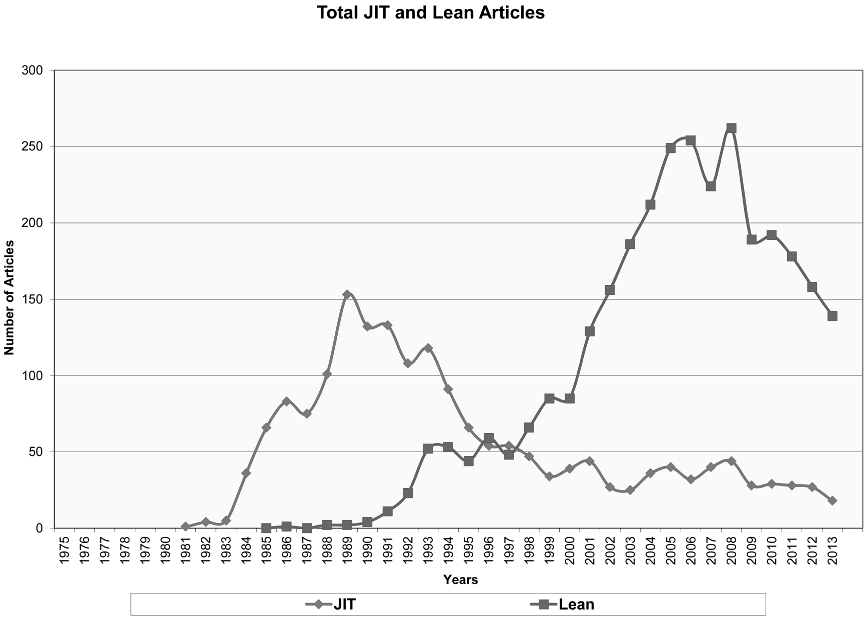

Figure 2.1. Life cycles for JIT and lean manufacturing.

makes sense, as the interest in a program starts out slow and then grows; the number of articles published about that program will gradually increase. You can actually see this in the graph as a rising curve going from the lower left to the upper right. At some point, the number of articles will hit a peak, and then begin to descend to the lower right hand corner of the graph. Hence, a full life cycle can be plotted using the number of articles written about that management improvement program.

We should note that some researchers think an S-shape curve is also possible (Ponzi & Koenig, 2002). This observation is feasible if one remembers that a life cycle can sometimes have a resurgence of activity near the end of its perceived useful existence. Although not a management improvement program, the business of miniature golf comes to mind. For those of us who grew up as Baby Boomers, as well as Baby Boomer parents, we need to remember that in the 1960s, miniature golf was an inexpensive, fun activity for the whole family. Such "golf courses" were very simple in format, with 18 holes, and a variety of easy and not so easy obstacles to putt the ball around before it finally entered the hole. Props were simple, such as a windmill with a rotating blade which meant the player had to wait until the optimum moment to make the putt. What few people may realize though is that miniature golf has had three resurgences over the years, with growth spurts in the 1930s, 1950s, and 1970s (Chandler, 2000). Today's courses are elaborate monstrosities with waterfalls, real sand, and must even meet ADA (Americans with Disabilities Act) approval (Sherborne, 2000). If one were to graph the life cycle of miniature golf, it would indeed look like an S-curve. Taking this observation to management improvement programs, we can see in Figure 2.1 that a later form of JIT, lean production, adds an upward spiral to give the curve its unique S-shape.

Certainly, the actual slope of a curve will vary in terms of its steepness. Carson and associates acknowledge that shapes will vary in terms of slope rates because of the existence of other management programs on the market that may impact the particular item under study (Carson et. al, 2000). However, a shape of some kind is plausible, most likely one that resembles a bell curve.

Life Cycle Stages

In addition to the shape, the stages of the life cycle are also of interest. Barbara Ettorre (1997) has shown improvement programs progressing through a five-stage life cycle:

1. **Discovery—"A buzzword is born"**. This is the stage where the new program gains recognition in the market. Consultants and popular management writers espouse the benefits of these new programs as something new and exciting that every manager should try.
2. **Wild Acceptance—"The idea catches fire"**. The number of adopters of the program increases dramatically. Keep in mind that many of these programs will be successfully implemented into organizations, while a few may not.
3. **Digestion—"The concept is subject to criticism"**. At this stage, users and non-users such as academics (university researchers and professors) will begin to question and critique the merits of the management improvement program. While the wild acceptance stage focused on only the benefits of the management improvement program, the digestion stage will critically evaluate the program from a more unbiased perspective.
4. **Disillusionment—"The idea does not solve all problems".** Shortcomings of the program become readily apparent. Interest and adoption decreases. This stage can occur for two reasons. First, the program may not actually be that good to begin with. Secondly, the program might not have been implemented well.

5. **Hard Core—"Only true believers remain."** Interest in the program is limited, with only a few adopters still practicing the remnants of the program.

Another way of looking at the life cycle stages has been offered by the Gartner Research Group. They developed a "hype cycle" with the following phases—Technology Trigger (beginning), Peak of Inflated Expectations (growth), Trough of Disillusionment (decline), Slope of Enlightenment (revival), and Plateau of Productivity (sustained level) (Fenn & Linder, 2005).

Both descriptions above follow a five-stage life cycle. Keep in mind that the length of the life cycle will vary. In the management research literature, programs with short life cycles are called fads while the more durable ones are considered fashions (Abrahamson, 1996).

The Beginning of the Life Cycle

What starts a program's life cycle? Many of the popular management programs originated as a focused effort within a company to address a specific problem. Examples include JIT at Toyota or Six Sigma at Motorola. The program may have been designed internally or with the aid of a consultant. Often, consultants package the program as an addition to their product line and promote the program to other potential clients.

In the early stages of a management improvement program, consultants and trade publications are often the primary sources of information about the program. A typical way for other practitioners to find out about the program is to attend conferences and workshops offered by consultants or trade associations. Of course, reading trade publications is another way to learn about these programs.

In the early stages, trade publication articles about the program are usually positive and describe the benefits of implementing such a program. This would be expected, as both consultants and the companies that are using these programs are generating publicity for themselves. As time goes on, business researchers in higher education begin to study the program and view it with greater objectivity. Their role is more reflective as they seek to analyze the program elements and identify the major causes of success or failure (Crandall, Crandall, & Ashraf, 2006). They often compile survey information that summarizes the actual results achieved, often reflecting a range of results, from high success to low success or even failures of the program.

The End of the Life Cycle

Since management improvement programs follow a life cycle, it is understandable that some of them will eventually go into decline. What happens to these programs at the end of their life cycles? Some programs that were considered fads, that is, they had a short life cycle, quickly disappear into oblivion. Programs that died because they simply did not work included the use of psychodrama and hypnosis-based consumer research (Colvin, 2004).

Some programs fade away because they are replaced by newer programs that are similar, but more up to date. For example, MRP (materials requirements planning) was replaced by MRP II. In a similar vein, many programs morph into a new program, such as JIT being succeeded by lean management or TQM by Six Sigma.

Some companies assimilate management programs into their normal day-to-day practices. While they may not have a definite identity as originating in a specific program, basic elements of the program remain as standard practice. For example, some companies may introduce self-directed work teams as part of a TQM program and continue their use of those teams even after discontinuing the formal TQM program.

Implications of Program Life Cycles for Management

What are the implications of knowing about management improvement program life cycles? After all, life cycles are interesting, and certainly good to know about when you are discussing something like a product life cycle. Marketing managers must be astutely aware of where a product is in the life cycle because of the need to constantly introduce new products at the right time. Being aware of management improvement program life cycles is different because as a manager, you are adopting a program into your organization, not producing the program like a marketing manager does with a new product. Nonetheless, we offer the following reasons why you should be aware of where an improvement program is in its life cycle.

1. Programs that are early in the life cycle have not been completely tested yet. In tracking the articles about management improvement programs, we have found that when the program is relatively new, and hence, still a novelty on the market; articles in trade publications will tend to be positive about the merits of the program. At this stage, you should view the program optimistically, but with

caution, remembering that because the program is new, all of the bugs have not been worked out yet.

2. Programs that are further into their life cycle have gone through more application and testing, and hence, have gained more credibility in terms of value added to the industry. Programs that have been around for several years have gone through a number of iterations of testing by various companies. As a result, these programs are more "seasoned" in terms of their ability to benefit a potential adopting organization. At this stage in the life cycle, articles that are written on the program may start to appear in academic journals, in addition to trade journals. In other words, there is a certain lag effect that occurs—trade journals and the popular press publish articles about these programs first, followed by more scholarly/academic journals next (Ryan & Hurley, 2004). This distinction is important to note when one recognizes that the role of academic journals is "to disseminate scholarly knowledge" (Amason, 2005, p. 157). This statement upholds the traditional view of academic research, to lead the market with new ideas on how to run effective organizations. Within the context of management improvement programs, this translates into offering a critical evaluation of the true merits of these programs. An analysis of the strengths and weaknesses, as well as the application limits are part of this scholarly evaluation. For management, information is more readily available to evaluate the merits of the program at this stage than at the earlier stages.
3. Programs near the end of their life cycle may be replaced by new programs that are more contemporary and relevant. Just as lean production succeeded JIT, and Six Sigma followed TQM, most successful programs eventually spawn new programs that are designed to correct developing problems or capture opportunities not addressed in the original program. For management, it is important to make the decision between choosing an older program, one that may not be around much longer but has proven reliable, versus, a newer program that may not have been tested as much, but could potentially offer more than the original program. Such is the same decision we often face when deciding upon versions of software.

As this chapter is being written, the university at one of the author's schools is currently adopting a newer version of a course management system that is so different from the previous version, that classes will be required for the faculty to learn the new version (of the same software). The hope is that the new version is worth the extra trouble of learning it.

Such is the case with newer versions of management improvement programs.

CONCLUDING COMMENT

To understand where management improvement programs come from, it is necessary to understand a brief history of management thought. As we have seen in this chapter, the Industrial Revolution spawned larger factories and organizations. These became complicated entities that were difficult to run efficiently, effectively, and with human dignity. The Scientific Management movement helped the organization's manufacturing processes run more efficiently. The Administrative Management movement added the infrastructure needed for management to run the organization more effectively. Finally, the Social Man movement stressed the need to treat the employees with dignity and respect. Modern management improvement programs contain elements of all three movements.

Understanding the life cycle of an improvement program is needed to help management in the evaluation and selection of the right program. Selecting a program that has not been tested or applied much in industry could yield a costly and ineffective decision if the program fails. On the other hand, selecting a proven program near the end of its lifecycle could yield a short duration of the desired results, when selecting an upgrade to the program would have been more effective.

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CHAPTER 3

INTRODUCTION TO INDIVIDUAL MANAGEMENT PROGRAMS

In Chapter 1, we provided a list of the programs to be described in this book. In this chapter, we will describe 50 management programs in a level of detail to provide a good understanding of each program, its objectives, benefits, issues, and an approach to its implementation. More formal definitions from the APICS Dictionary (Blackstone, 2013) are included in Appendix A of this chapter and at the beginning of each program's description in subsequent chapters. These 50 programs were shown in Table 1.1 and Figure 1.2 in Chapter 1. While other classifications could have been used, we believe that the ones listed adequately differentiate among the programs and provide a guide to the type of improvement effort needed.

Planning and Control—Chapter 4

Planning and control programs are used to plan production and service operations. They usually begin with a demand forecast and translate that into production, inventory and resources plans. The programs described in this section—MRP, MRPII and ERP—were developed to plan the production, or purchasing, requirement for complex assembled products, such as appliances and automobiles. They incorporated the concepts

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of independent and dependent demand. Independent demand refers to finished products, such as an automobile, and dependent demand refers to those components in an automobile, such as engines and wheels.

Materials requirements planning (MRP) was developed first. It could determine quantities and time requirements for products, but did not provide for a way to monitor progress in achieving the plan. Its plans assumed infinite capacity—it ignored capacity requirements—and had other limiting constraints.

Manufacturing resources requirements (MRP II) attempted to extend the scope of MRP beyond the shop floor to link with marketing forecast and accounting cost systems. This was progress, but MRP II still used infinite capacity planning and had to be supplemented with special software programs to develop more realistic production schedules.

Enterprise resources planning (ERP) systems were designed to be even broader and included more integrated links with a number of separate modules, including not only marketing and finance, but also engineering and human resources. While it achieved greater integration of functions, it still did not include, in most cases, finite capacity planning.

Project management (PM) programs were developed to help plan and manage long, complex projects. These projects often included activities with multiple, concurrent sub-activities, requiring different types and amounts of resources, with different activity times. The major programs were Critical Path Method (CPM), originally developed for construction projects, and Program Evaluation and Review Technique (PERT), developed by the U.S. Navy during the design and building of the Polaris submarine.

Planning programs were a major step forward in developing software that would make it possible to plan production and resource requirements faster and for more complex manufacturing environments. However, they needed to be supplemented with systems that could provide more realistic production schedules, or execution systems.

Execution Programs—Chapter 5

The planning programs could develop when and how much was needed, both at the macro and micro levels. However, they needed additional programs to decide how best to schedule the work through procurement, manufacturing and distribution processes. These are classified as execution systems and include computer integrated manufacturing (CIM), manufacturing execution systems (MES), warehouse management systems (WMS) and advanced planning and scheduling (APS).

CIM was developed in the 1970s but has suffered by a lack of clear identity. Its scope ranges from a localized view, such as in flexible manufacturing systems (FMS) to being promoted as even broader than ERP systems. We will present it as being a system for activating individual pieces of equipment, such as the use of numeric control (NC) capability. It also included the linking of individual pieces of equipment into automatic assembly lines or other forms of automated processing.

Warehouse management systems (WMS) focused on warehouse operations, as contrasted with the manufacturing area, and used computers and automated transport capabilities to increase the automation within warehouse operations.

Manufacturing execution systems (MES) represented an approach to how best to link machines and process steps with information collection and control devices. It includes feedback on operations and introduces controllers that can adjust equipment to keep it running as intended. As an oversimplification, an MES system digitizes and collects data about actual operations and sends this data to the ERP system, where it is stored and made available to other systems.

Advanced planning and scheduling (APS) systems were designed to overcome the infinite capacity problem generated within the planning systems. It used algorithms and mathematical programming to develop optimized schedules that met the requirements generated by the planning systems. An APS system obtains data from ERP systems for use in the planning process.

We have also included the Theory of Constraints as an execution system because of its pioneering work in introducing the "drum-buffer-rope" approach to dealing with bottleneck operations.

Cost and Waste Reduction Programs—Chapter 6

While most management programs claim that cost reduction is a benefit of that program, most programs also dislike being labeled as "just" a cost reduction program. Consequently, we agree that the programs included in this section provide benefits beyond cost reduction. However, they also represent programs that make cost reduction a major emphasis. If waste can be aligned with costs, then these programs can be said to have cost and waste reduction as their primary focus.

Just-in-Time (JIT) originated with the Toyota organization as a way to reduce inventories and to streamline their production and distribution processes. This concept was known as stockless production, zero inventories and The Toyota Production System before the JIT label became universally accepted. It was designed for repetitive industries but found some acceptance in related industries.

Lean manufacturing was a concept introduced in the late 1980s, with its origin in the global automotive industries. It incorporated many of the concepts found in JIT but its name seems to capture more accurately its objective of identifying the desired flow of materials and smoothing that flow by removing obstacles to the flow.

Business process reengineering (BPR), introduced in the 1980s, proposed radical changes in processes to achieve dramatic improvements. It proposed that incremental improvements were inadequate and that companies should take a "clean slate" approach to redesigning the best process available. BPR had a few notable successes but faltered because of its disruptive effect, especially in the area of human resource management.

Business Process Outsourcing (BPO) is a program that has become popular in the past decade. It involves contracting with external suppliers to perform work previously done in-house. Much of the motivation has been to reduce the cost of performing the activity and reducing the investment in resources to perform the activity internally. Outsourcing, especially offshore outsourcing, has become one of the most discussed business activities during the first decade of the twenty-first century.

Value analysis was a concept introduced as far back as the 1950s, when it was endorsed by the U. S. military. It never materialized as a popular program; however, in recent years, it is reappearing. Its basic premise is that the basic value of a product or service should be identified and that knowledge used in design of future products and services.

Quality Improvement Programs—Chapter 7

Quality improvement has become a critical success factor for most organizations, whether manufacturing, service or nonprofit.

The quality improvement movement started with statistical process control techniques developed at Western Electric in the 1920s, spearheaded by Walter Shewhart. Two men who later became recognized internationally as quality gurus were Joseph J. Juran and W. Edward Deming. They developed their basic understanding of the quality movement while at Western Electric, working with Shewhart.

Statistical process control (SPC) focused on improving individual operations. A related topic was lot acceptance sampling, in which individual lots of incoming materials could be sample tested to see whether it should be accepted or rejected.

As the quality movement began to catch on, one of the companies that endorsed its use was General Electric. While at GE, Arnold Fieganbaum wrote a book called *Total Quality Control*, in which he described an approach that spanned from product development through manufacturing to final product distribution. This was one of the early efforts to present quality improvement as an integrated management program and was called Total Quality Control (TQC).

Total Quality Management (TQM) emerged in the mid-1980s as foreign competition, especially from Japan in the automotive industry, reawakened the realization that quality was an important issue in manufacturing. TQM was presented an all-encompassing program that included both statistical and behavioral considerations. The use of teams and employee empowerment were an integral part of TQM. TQM was highly promoted as useful to not only manufacturing but also service companies. While some of the results were positive, a number of organizations found that their TQM programs were only moderately successful, if at all.

The disappointing results from many TQM programs gave rise to a more disciplined approach to become known as Six Sigma. Motorola introduced the concept in the late 1980s and Jack Welch at General Electric soon endorsed it. While Six Sigma incorporated many of the concepts from TQM, it packaged them differently and insisted on more formal training, closer monitoring of actions and results, thoroughly prepared team leaders and top management commitment. The more structured approach seems to be working. Six Sigma programs can be found in both manufacturing and service organizations. It is still in the growth phase of its life cycle.

One program that promotes integration among functions within a company is Quality Function Deployment (QFD). The unfortunate choice of names is misleading. While QFD does consider quality, its foremost purpose is to design a product or service that considers customer needs or wants, internal process capabilities and competitor strengths and weaknesses. It is a technique that has more potential than is currently being realized.

Genichi Taguchi, a Japanese scientist, originated the "quality loss function," a concept that broadened the scope of quality costs to society. While there are direct costs of poor quality, Taguchi extended this cost to include the negative effects on society in general. While his ideas never resulted in a specific management program of note, his concept is prized, especially in the academic textbooks.

Performance Measurement Programs—Chapter 8

Performance measurement has been an area of interest for management for centuries. While there was interest, it is difficult to identify a specific program that focused on performance measurement. In general, the finance, or accounting, function was generally considered responsible for developing ways to measure the performance of operations and other functions within an organization.

Some of the early attempts at program development included management by objectives (MBO) and standard costing. These, and other, programs suffered because of the difficulty in relating the results with the financial accounting system, which became the official barometer of performance, especially as public companies grew and were required to present audited financial statements.

Activity-based-costing (ABC) was developed to bridge the gap between micro performance measurement and a macro link with the financial accounting system. It focused heavily on devising a better way of allocating overhead expenses to products and services costs. It did not distort the financial accounting system; it supplemented it with greater detail. As a result, it gained favor. However, it had a major drawback in that it required a great deal more detail and complexity in the reporting and assignment of expense categories. While this examination of the detail provided opportunities to eliminate, simplify and combine, ABC programs faltered in many organizations because of the increased cost and complexity.

Activity-based management (ABM) extended the role of ABC to doing something with the information developed in the ABC program. While it offered a logical approach, it was difficult to distinguish between the concepts of ABC and ABM.

The Balanced Scorecard (BCS) extended ABC and ABM into the strategic area. It included not only the financial perspective but also the customer perspective, the business process perspective, and the innovation and learning perspective. This program appears to be gathering support but it is difficult to know how widespread it is used.

Response Time Reduction Programs—Chapter 9

During the latter half of the twentieth century, lower costs and higher quality became basic objectives for most companies. By the last quarter of the century, it became apparent that reduced response times were becoming almost as important. Accordingly, companies began to design programs specifically aimed at reducing response times.

The Quick Response System (QRS) was developed in the textile and clothing industries. It was designed to offer a way to quickly replenish products that sold in the early days of a season. In the past, retailers usually had to order enough merchandise to last the entire season. As a result, they sold out of the fast moving items and were forced to mark down or otherwise try to dispose of slow moving items. The QRS offered a way to order enough to get the season started and then to reorder those items that sold best.

The Efficient Consumer Response (ECR) was an extension of the QRS to the grocery industry. As the number of products increased, it became unrealistic to order the same quantities of each item and ECR was an attempt to reduce that need. It also served to help companies "try out" new products with minimal quantities and then to reorder those that proved to be successful.

Vendor Managed Inventory (VMI) was an extension of the rack jobber or service merchandise programs that have been around for at least the last five decades. VMI charges the supplier with the responsibility for managing their customer's inventory. As point-of-sale (POS) terminals and electronic communication systems become more effective, it makes it easier for vendors to have insight into the flow of their goods through their customers.

Collaborative Planning, Forecasting and Replenishment (CPFR) brings the previous three programs to a new level by introducing the need for collaboration among entities along the supply chain. One of the key areas for collaboration is in preparing demand forecasts. Companies not only share demand information but also jointly agree to the demand forecast. This added knowledge provides the suppliers with a greater insight into the potential demand, especially as it relates to events planned by their customers, such as sales promotions.

Flexibility Enhancement Programs—Chapter 10

After cost, quality and response time, flexibility appears to be emerging as a fourth critical success factor for businesses. While the first three can be defined and measured to a reasonable level, flexibility remains a somewhat ambiguous term.

If we were to design a continuum with standard mass production on the left and mass customization on the right, flexible operations would be somewhere in the middle. Flexibility, according to the APICS Dictionary, is the capability to deal with a number of factors, including product mix, design changeover, product modifications, volume changes, rerouting requirements and material changes. The implication is that the existing processes can be adapted to handle the required changes, whether planned or inadvertent.

Agile processes, or agility, imply a capability to move smoothly among a wide variety of product choices in a systematic way to provide what the customers want. And to do this within the constraints of cost, quality, and response time requirements. The implication is that the processes have been designed to handle the variety as a regular part of making relatively standard products.

Mass customization carries agility to a higher level by requiring that the processes be designed to not only produce a wide variety of standard products but also customize those standard products to meet the needs of individual customers. Mass customization requires the highest level of flexibility and agility. The move from mass production to mass customization implies a shift from making high volumes of standard products to making high volumes of customized products. It requires a company to determine what the customer wants and then to make that product to the customer's specifications. To do this, a company has to develop close relationships with customers to determine their wants and flexible processes to be able to make the product.

Flexibility enhancement programs focus on using the modularity concept in both products and processes. Modular products make it possible to move from a make-to-stock (MTS) orientation to an assemble-to-order (ATO) or even a make-to-order (MTO) position. Modular processes involve using a combination of machines and operators to achieve the best balance between the two resources—enough automation to achieve speed and efficiency and enough operator input to achieve flexibility.

Information Technology (IT) and Communications Systems—Chapter 11

Advances in information technology (IT) are providing the connectivity required within and between organizations. Intra- and inter-organizational communications systems are making coordination and cooperation among supply chain members a reality. The advent of the internet began to open up the attractiveness of electronic communications to all companies. Almost all organizations have some access to the internet and there are a number of ways to use it to communicate with other organizations. While the cost hurdle has been lowered, the questions of confidentiality and information security are still troublesome considerations. Companies will likely find a way through the maze of options to reach a satisfactory way of communicating electronically with their suppliers and customers.

Electronic data interchange (EDI) has been a viable technology for at least three decades. However, its initial investment costs are high and only a limited number of companies considered it an attractive alternative. Those that used it found it to be reliable and efficient. While third party providers extended the scope, traditional EDI did not achieve mass use.

Electronic communications has opened up two major ways of doing business. Business-to-business (B2B) involves one business selling products or services to another business. Business-to-consumer (B2C) involves a business selling products or services directly to an individual consumer. While B2C is more widely publicized, B2B provides a greater volume of business.

Automatic Identification Systems (AIS) are systems that use coding technologies (bar codes and RFID) to identify products throughout their movement through supply chains. The use of computer-readable codes make it possible to move products much faster and with a minimum of errors through transfer points such as distribution centers and point of sale registers at retail stores.

A Decision Support System (DSS) is a system, usually computer based, that can help in decision-making, by storing data and algorithms that fit certain types of decisions.

Interorganizational systems (IOS) are systems that enable organizations to communicate with one another in conducting business transactions and the related communications necessary to make those transactions successful. IOS involve a variety of IT technologies and services, depending on the needs of the organizations involved.

Service-Oriented Architecture (SOA), Software as a Service (SaaS) and Cloud Computing are new information technologies that enable users to avail themselves of external resources to perform computer-related activities that the companies do not have the internal capabilities to complete themselves.

Electronic communications has great future possibilities. Teleconferences are just beginning to become an accepted medium of communication; they offer great opportunities for reducing travel costs and promoting more collaborative relationships. Health care is another area that may benefit from electronic communication systems, in such areas as using RFID tags to reduce medication errors to long-range diagnostics.

Integration Programs—Chapter 12

Integration programs are designed to more closely link one entity with another, such as in supply chain design. The concept of core competencies suggests that a company should concentrate its resources on doing those things it does best and outsource the other needed processes and services. In contrast to vertical integration, in which a company owns all of the necessary activities, the current view is that a company must develop business relationships with a number of other organizations to achieve comparable results at a much lower investment cost.

New Product Development (NPD) is a strategic initiative that aims to develop products that fit within the strategic planning framework of a company. It involves multiple functions within the company to be sure that customer preferences are recognized as well as internal considerations such as cost, return on investment, manufacturability, serviceability and recyclability.

Sales and operations planning (S&OP) is a program that was first developed at least three decades ago but had difficulty in being accepted, perhaps because they was not sufficient recognition of the need for integrating the marketing and operations functions. In recent years, S&OP has experienced a new level of interest and is now considered a basic part of achieving collaboration, both within a company and with external trading partners.

Supply chain management (SCM) is, of course, the ultimate integrating program. It envisions the linking of a series of organizations so as to achieve a smooth flow of goods and services from the raw material state to the finished goods state. While almost every organization is conscious of the need for effective supply chains, most are still in the early stages of successful implementation.

Customer relationship management (CRM) is an extension of the supply chain toward the customer. It is a more formal approach to determining customer needs and designing approaches to satisfying those needs.

Supplier relationship management (SRM) is an extension of the supply chain back toward the supplier. As is CRM, SRM is a more formal approach to determining how best to deal with suppliers to achieve the desired results.

Product Lifecycle Management (PLM) is an approach to product design that attempts to capture all of the information about a product at the design stage and retail access to that information throughout the product's lifecycle, including the reverse logistics portion.

Building relationships is the core of integrating functions. This requires an extension of coordination and cooperation into collaboration. Collaboration requires trust, and trust is an elusive element in most of today's business relationships. Building trust is one of the challenges for the future.

Management Programs—Chapter 13

Management programs deal primarily with strategic decision areas, as opposed to operational decisions. They represent major shifts in the way a company does business. These programs require executive decisions and involvement if they are to be successful. They represent major commitments of resources and require significant changes in infrastructure and culture. They involve essentially all employees, at all levels of the company.

Management by Objectives (MBO) is a management program that was first introduced in the 1950s. While it has great intuitive appeal, it has been a difficult concept to implement because of the complexity and dynamic characteristics of modern organizations.

Strategic management is the planning and implementation of strategic initiatives by an organization. It goes beyond the day-to-day operations planning and implementation by considering longer-term opportunities and threats to the organization.

Knowledge Management Systems (KMS) involve the conversion of data to information to knowledge, and finally to wisdom. Most companies are collecting more data than they are able to use. The age of "Big Data" is here and sophisticated methods are needed to interpret the data and convert it to useful information. Even beyond that, a company has to have some way to store and retain that knowledge for future use. Most organizations are just beginning the journey along the knowledge management corridor.

Risk Management. As companies move into supply chains that are more complex and spread throughout the world, they increase the likelihood there will be disruptions. While some of the disruptions may be minor, some can, and have been, major, such as in the case of political upheaval, hurricanes, earthquakes and fires. Companies need a formal program of risk and crisis management in today's volatile environment.

Virtual organization. Vertical integration was epitomized by Henry Ford in the River Rouge plant where the company mined iron ore, carried it to the plant and, along with other materials, converted it into Model T vehicles, all within the Ford ownership. Virtual integration involves linking different companies into a closely knit "virtual" organization, in which all of the organizations work together for the good of the total value chain. Virtual organizations involve tightly linking participants in a new product program or some other major project.

Chaos theory attempts to look at businesses and other organizations as dynamic and largely unpredictable. Using past history to forecast future trends and events is insufficient. Linear patterns are giving way to non-linear patterns which are much more difficult to manage with conventional tools and techniques.

Summary

We have summarized some of the programs that will be described in detail in the following chapters. While each program has specific objectives and may be treated as a separate project, almost all of them overlap with other programs to some extent. One common objective is to improve the performance of the organization in which implemented. We hope you find one or more programs in the following chapters that will be of value to your organization.

APPENDIX A: DEFINITIONS FROM THE APICS DICTIONARY (FOURTEENTH EDITION, 2013)

Definitions No. 36 (Interorganizational Systems), No. 39 (New Product Development) and No. 50 (Chaos Theory) are from Wikipedia (2013).

Planning and Control Programs

1. **Material Requirements Planning (MRP)**—A set of techniques that uses bill of material data, inventory data, and the master production schedule to calculate requirements for materials. It makes recommendations to release replenishment orders for material. Further, because it is time-phased, it makes recommendations to reschedule open orders when due dates and need dates are not in phase. Time-phased MRP begins with the items listed on the MPS and determines (1) the quantity of all components and materials requ2ired to fabricate those items and (2) the date that the components and material are required. Time-phased MRP is accomplished by exploding the bill of material, adjusting for inventory quantities on hand or on order, and offsetting the net requirements by the appropriate lead times.
2. **Manufacturing Resource Planning (MRP II)**—A method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer what-if question. It is made up of a variety of processes, each linked together: business planning, production planning (sales and operations planning), master production scheduling, material requirements planning, capacity requirements planning, and the execution support systems for capacity and material. Output from these systems is integrated with financial reports such as the business plan, purchase commitment report, shipping budget, and inventory projections in dollars. Manufacturing resource planning is a direct outgrowth and extension of closed-loop MRP.

3. **Enterprise Resources Planning (ERP)—**Framework for organizing, defining, and standardizing the business processes necessary to effectively plan and control an organization so the organization can use its internal knowledge to seek external advantage.
4. **Project Management**—The use of skills and knowledge in coordinating the organizing, planning, scheduling, directing, controlling, monitoring, and evaluating of prescribed activities to ensure that the stated objectives of a project, manufactured good, or service are achieved. See: project.

    - **Project**—An endeavor with a specific objective to be met within predetermined time and dollar limitations and that has been assigned for definition or execution. See: project manufacturing, project management.
    - **Critical path method (CPM)**—A network planning technique for the analysis of a project's completion time used for planning and controlling the activities in a project. By showing each of these activities and their associated times, the critical path, which identifies those elements that actually constrain the total time of the project, can be determined. See: critical chain method, network analysis, critical activity, critical path.
    - **Program evaluation and review technique (PERT)**—In project management, a network analysis technique in which each activity is assigned a pessimistic, most likely, and optimistic estimate of its duration. The critical path method is then applied using a weighted average of these times for each node. PERT computes a standard deviation of the estimate of project duration. See: critical path method, graphical evaluation and review technique, and network analysis.

Execution Programs

5. **Computer-Integrated Manufacturing (CIM)**—The integration of the total manufacturing organization through the use of computer systems and managerial philosophies that improve the organization's effectiveness; the application of a computer to bridge various computerized systems and connect them into a coherent, integrated whole. For example, budgets, CAD/CAM, process controls, group technology systems, MRP II, and financial reporting systems are linked and interfaced.

6. **Warehouse Management System (WMS)**—A computer application system designed to manage and optimize workflows and the storage of goods within a warehouse. These systems often interface with automated data capture and enterprise resources planning systems.
7. **Manufacturing Execution System (MES)**—Programs and systems that participate in shop floor control, including programmed logic controllers and process control computers for direct and supervisory control of manufacturing equipment; process information systems that gather historical performance information, then generate reports; graphical displays; and alarms that inform operations personnel what is going on in the plant currently and a very short history into the past. Quality control information is also gathered and a laboratory information management system may be part of this configuration to tie process conditions to the quality data that are generated. Thereby, cause-and-effect relationships can be determined. The quality data at times affect the control parameters that are used to meet product specifications either dynamically of off line.
8. **Advanced Planning and Scheduling (APS)**—Techniques that deal with analysis and planning of logistics and manufacturing over the short, intermediate, and long-term time periods. APS describes any computer program that uses advanced mathematical algorithms or logic to perform optimization or simulation on finite capacity scheduling, sourcing, capital planning, resource planning, forecasting, demand management, and others. These techniques simultaneously consider a range of constraints and business rules to provide real-time planning and scheduling, decision support, available-to-promise, and capable-to-promise capabilities. APS often generates and evaluates multiple scenarios. Management then selects one scenario to use as the "official plan." The five main components of APS systems are (1) demand planning; (2) production planning; (3) production scheduling; (4) distribution planning; and (5) transportation planning.
9. **Theory of Constraints (TOC**)—A holistic management philosophy developed by Dr. Eliyahu M. Goldratt that is based on the principle that complex systems exhibit inherent simplicity. Evan a very complex system comprising thousands of people and pieces of equipment can have, at any given time, only a very, very small number of variables—perhaps only one, known as a constraint—that actually limit the ability to generate more of the system's goal.

Cost and Waste Reduction

10. **Just-in-Time (JIT)**—A philosophy of manufacturing based on planned elimination of all waste and on continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery, and includes all stages of conversion from raw material onward. The primary elements of Just-in-time are to have only the required inventory when needed; to improve quality to zero defects; to reduce lead times by reducing setup times, queue lengths, and lot sizes; to incrementally revise the operations themselves; and to accomplish these activities at minimum cost. In the broad sense, it applies to all forms of manufacturing—job shop, process, and repetitive—and to many service industries as well. Syn: short-cycle manufacturing, stockless production, zero inventories.
11. **Lean Production**—A philosophy of production that emphasizes the minimization of the amount of the resources (including time) used in the various activities of the enterprise. It involves identifying and eliminating non-value-adding activities in design, production, supply chain management, and dealing with the customers. Lean producers employ teams of multiskilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products in potentially enormous variety. It contains a set of principles and practices to reduce cost through the relentless removal of waste and through the simplification of all manufacturing and support processes. Syn: lean, lean manufacturing.
12. **Business Process Reengineering (BPR)**—A procedure that involves the fundamental rethinking and radical redesign of business processes to achieve dramatic organizational improvements in such critical measures of performance as cost, quality, service, and speed. Any BPR activity is distinguished by its emphasis on (1) process rather than functions and products; and (2) the customers for the process. Syn: reengineering.
13. **Business Process Outsourcing (BPO)**—Contracting with third parties to perform non-core activities within a business. Functions often outsourced include human resources, accounts receivable, accounts payable, and payroll.
14. **Value Analysis**—The systematic use of techniques that identify a required function, establish a value for that function, and finally provide that function at the lowest overall cost. This approach

focuses on the functions of an item rather that the methods of producing the present product design.

Quality Improvement Programs

15. **Statistical Process Control (SPC)**—The application of statistical techniques to monitor and adjust an operation. Often the term statistical process control is used interchangeably with statistical quality control, although statistical quality control includes acceptance sampling as well as statistical process control.
16. **Total Quality Control (TQC)**—The process of creating and producing the total composite good and service characteristics (by marketing, engineering, manufacturing, purchasing, etc.) through which the good and service will meet the expectations of customers.
17. **Total Quality Management (TQM)**—A term coined to describe Japanese-style management approaches to quality improvement. Since then, total quality management (TQM) has taken on many meanings. Simply put, TQM is a management approach to long-term success through customer satisfaction. TQM is based on the participation of all members of an organization in improving processes, goods, services, and the culture in which they work. The methods for implementing this approach are found in teachings of such quality leaders as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, J. M. Juran, and Genichi Taguchi.
18. **Quality Function Deployment (QFD)**—A methodology designed to ensure that all the major requirements of the customer are identified and subsequently met or exceeded through the resulting product design process and the design and operation of the supporting production management system. QFD can be viewed as a set of communication and translation tools. QFD tries to eliminate the gap between what the customer wants in a new product and what the product is capable of delivering. QFD often leads to a clear identification of the major requirements of the customers. These expectations are referred to as the voice of the customer (VOC). See: house of quality.
19. **Six Sigma Quality**—A term generally to indicate that a process is well controlled, i.e., tolerance limits are ± 6 sigma from the centerline in a control chart. The term is usually associated with

Motorola, which named one of its key operational initiatives Six-Sigma Quality.

Performance Measurement Programs

20. **Activity-Based Cost Accounting (ABC)**—A cost accounting system that accumulates costs based on activities performed and then uses cost drivers to allocate these costs to products of other bases, such as customers, markets, or projects. It is an attempt to allocate overhead costs on a more realistic basis that direct labor or machine hours. Syn: activity-based costing. See: absorption costing.
21. **Activity-Based Management (ABM)**—The use of activity-based costing information about cost pools and drivers, activity analysis, and business processes to identify business strategies; improve product design, manufacturing, and distribution; and remove waste from operations. See: activity-based costing.
22. **Balanced Scorecard**—A list of financial and operational measurements used to evaluate organizational or supply chain performance. The dimensions of the balanced scorecard might include customer perspective, business process perspective, financial perspective, and innovation and learning perspectives. It formally connects overall objectives, strategies, and measurements. Each dimension has goals or measurements.
23. **Key Performance Indicators (KPI)**—A financial or nonfinancial measure that is used to define and assess progress toward specific organizational goals and typically is tied to an organization's strategy and business stakeholders. A KPI should not be contradictory to other departmental or strategic business unit performance measures.

Response Time Reduction

24. **Quick Response Program (QRP)**—A system of linking final retail sales with production and shipping schedules back through the chain of supply; employs point-of-sale scanning and electronic data interchange, and may use direct shipment from a factor or a retailer.
25. **Efficient Consumer Response (ECR)**—(1) A grocery industry-based, demand-driven replenishment system that links suppliers to

develop a large flow-through distribution network. Information technology is designed to enable suppliers to anticipate demand. Manufacture is initiated based on point-of-sale information. Accurate, instantaneous data are essential to this concept. (2) A management approach that streamlines the supply chain by improving its effectiveness in providing customer service and reducing costs through innovation and technology.

26. **Vendor-Managed Inventory (VMI)**—A means of optimizing supply chain performance in which the supplier has access to the customer's inventory data and is responsible for maintaining the inventory level required by the customer. This activity is accomplished by a process in which resupply is done by the vendor through regularly scheduled reviews of the on-site inventory. The on-site inventory is counted, damaged or outdated goods are removed, and the inventory is restocked to predefined levels. The vendor obtains a receipt for the restocked inventory and accordingly invoices the customer. See: continuous replenishment.
27. **Collaborative Planning, Forecasting, and Replenishment (CPFR)**—(1) A collaboration process whereby supply chain trading partners can jointly plan key supply chain activities from production and delivery of raw materials to production and delivery of final products to end customers. Collaboration encompasses business planning, sales forecasting, and all operations required to replenish raw materials and finished goods. (2) A process philosophy for facilitating collaborative communications. CPFR is considered a standard, endorsed by the Voluntary Interindustry Commerce Standards. Syn: collaborative planning.

Flexibility Improvement Programs

28. **Flexibility**—(1) The ability of the manufacturing system to respond quickly, in terms of range and time, to external or internal changes. Six different categories of flexibility can be considered: mix flexibility, design changeover flexibility, modification flexibility, volume flexibility, rerouting flexibility, and material flexibility (see each term for a more detailed discussion). In addition, flexibility involves concerns of product flexibility. Flexibility can be useful in coping with various types of uncertainty (regarding mix, volume, and so on). (2) The ability of a supply chain to mitigate, or neutralize, the risks of demand forecast variability, supply continuity variability, cycle time plus lead-time uncer-

tainty, and transit time plus customs-clearance time uncertainty during periods of increasing or diminishing volume.

- Mix flexibility—The ability to handle a wide range of products or variants by using equipment that has short setup times.
- Design changeover flexibility—The capability of the existing production system to accommodate and introduce a large variety of major design changes quickly.
- Modification flexibility—The capability of the transformation process to quickly implement minor product design changes.
- Volume flexibility—The ability of the transformation process to quickly accommodate large variations in production levels.
- Rerouting flexibility—Accommodating unavailability of equipment by quickly and easily using alternate machines in the processing sequence.
- Material flexibility—the ability of the transformation process to handle unexpected variations in material inputs.

29. **Agile or Agility**—The ability to successfully manufacture and market a broad range of low-cost, high-quality products and services with short lead times and varying volumes that provide enhanced value to customers through customization. Agility merges the four distinctive competencies of cost, quality, dependability, and flexibility.
30. **Mass Customization**—The creation of a high-volume product with large variety so that a customer may specify his or her exact model out of a large volume of possible end items while manufacturing cost is low because of the large volume. An example is a personal computer order in which the customer may specify processor speed, memory size, hard disk size and speed, removable storage device characteristics, and many other options when PCs are assembled on one line and at low cost.

Information Technology (IT) and Communications Programs

31. **Electronic Data Interchange (EDI)**—The paperless (electronic) exchange of trading documents, such as purchase orders, shipment authorizations, advanced shipment notices, and invoices, using standardized document formats.

32. **E-Procurement or Business-to-Business Commerce (B2B)**—Business being conducted over the Internet between businesses. The implication is that this connectivity will cause businesses to transform themselves via supply chain management to become virtual organizations, reducing costs, improving quality, reducing delivery lead time, and improving due-date performance.
33. **E-Commerce or Business-to-Consumer Sales (B2C)**—Business being conducted between businesses and final consumers largely over the Internet. It includes traditional brick and mortar businesses that also offer products online and businesses that trade exclusively electronically.
34. **Automatic Identification Systems (AIS)**—A system that can use various means, including bar code scanning and radio frequencies, to sense and load data in a computer.

    - **Bar code**—A series of alternating bars and spaces printed or stamped on parts, containers, labels, or other media, representing encoded information that can be read by electronic readers. A bar code is used to facilitate timely and accurate input of data to a computer system.
    - **Radio frequency identification (RFID)**—A system using electronic tags to store data about items. Accessing these data is accomplished through a specific radio frequency and does not require close proximity or line-of-sight access for data retrieval.

35. **Decision Support System (DSS)**—A computer system designed to assist managers in selecting and evaluating courses of action by providing a logical, usually quantitative, analysis of the relevant factors.
36. **Interorganizational System (IOS)**—An **interorganizational system (IOS)** is one which allows the flow of information to be automated between organizations in order to reach a desired *supply-chain management* system, which enables the development of competitive organizations. This supports forecasting client needs and the delivery of products and services. IOS helps to better manage buyer-supplier relationships by encompassing the full depths of tasks associated with business processes company-wide. In doing these activities, an organization is able to increase the productivity automatically; therefore, optimizing communication within all levels of an organization as well as between the organization and the supplier. For example, each t-shirt that is sold in a retail store

is automatically communicated to the supplier who will, in turn, ship more t-shirts to the retailer. (Wikipedia 2013)

37. **Service-Oriented Architecture (SOA)**—A style of information technology (IT) design that guides all aspects of creating and using business services throughout their life cycles, as well as defining and providing the IT infrastructure that enables different computer applications to exchange data and participate in business processes, regardless of the operating systems or programming languages underlying those applications.
38. **Software as a Service (SaaS)**—Computer services are provided by a third party that keeps all of the software and hardware in its place of business and the company using the services accesses them via the internet. A very common technique used to outsource technological state-of-the-art costs that can be avoided. **Cloud computing**—An emerging way of computing where data is stored in massive data centers which can be accessed from any connected computers over the internet.

Integration Programs

39. **New Product Development (NPD)**—In *business* and *engineering*, **new product development** (NPD) is the complete process of bringing a new *product* to market. A product is a set of benefits offered for exchange and can be tangible (that is, something physical you can touch) or intangible (like a service, experience, or belief). There are two parallel paths involved in the NPD process: one involves the idea generation, *product design* and detail engineering; the other involves market research and *marketing analysis*. Companies typically see new product development as the *first stage* in generating and commercializing new product within the overall strategic process of *product life cycle management* used to maintain or grow their market share. (Wikipedia 2013)
40. **Sales and Operations Planning (S&OP)**—A process to develop tactical plans that provide management the ability to strategically direct its businesses to achieve competitive advantage on a continuous basis by integrating customer-focused marketing plans for new and existing products with the management of the supply chain. The process brings together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans. It is performed at least once a month and is reviewed by management at an aggregate

(product family) level. The process must reconcile all supply, demand, and new-product plans at both the detail and aggregate levels and tie to the business plan. It is the definitive statement of the company's plans for the near to intermediate term, covering a horizon sufficient to plan for resources and to support the annual business planning process. Executed properly, the sales and operation planning process links the strategic plans for the business with its execution and reviews performance measurements of continuous improvement. See: aggregate planning, production plan, production planning, sales plan, tactical planning.

41. **Supply Chain Management (SCM)**—The design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging world-wide logistics, synchronizing supply with demand, and measuring performance globally. Supply chain—The global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution, and cash. See: supply chain design, and supply chain planning.
42. **Customer Relationship Management (CRM)**—A marketing philosophy based on putting the customer first. The collection and analysis of information designed for sales and marketing decision support (as contrasted to enterprise resources planning information) to understand and support existing and potential customer needs. It includes account management, catalog and order entry, payment processing, credits and adjustments, and other functions. Syn: customer relations management.
43. **Supplier Relationship Management (SRM)**—A comprehensive approach to managing an enterprise's interactions with the organizations that supply the goods and services the enterprise uses. The goal of SRM is to streamline and make more effective the processes between an enterprise and its suppliers. SRM is often associated with automating procure-to-pay business processes, evaluating supplier performance, and exchanging information with suppliers. An e-procurement system often comes under the umbrellas of a supplier relationship management of family of applications.
44. **Product Lifecycle Management (PLM)**—The process of facilitating the development, use, and support of products that customers want and need. PLM helps professional envision the creation and preservation of product information, both to the customer and along the reverse-logistics portion of the supply chain.

Management Programs

45. **Management by Objectives (MBO)**—A participative goal-setting process that enables the manager or supervisor to construct and communicate the goals of the department to each subordinate. At the same time, the subordinate is able to formulate personal goals and influence the department's goals.
46. **Strategic Management**—The strategy of an enterprise identifies how a company will function in its environment. The strategy specifies how to satisfy customers, how to grow the business, how to compete in its environment, how to manage the organization and develop capabilities within the business, and how to achieve financial objectives.
47. **Knowledge Management System (KMS)**—Concept of information being used by executives, managers, and employees to more effectively produce product, interface with customers, and navigate through competitive markets.
48. **Risk Management**—the process of developing a plan to avoid risks and to mitigate the effect of those that cannot be avoided.
49. **Virtual Organization**—The logical extension of outpartnering. With the virtual corporation, the capabilities and systems of the firm are merged with those of the suppliers, resulting in a new type of corporation where the boundaries between the suppliers' systems and those of the firm seem to disappear. The virtual corporation is dynamic in that the relationships and structures change according to the changing needs of the customer.
50. **Chaos Theory**—A field of study in mathematics, with applications in several disciplines including meteorology, physics, engineering, economics, biology, and philosophy. Chaos theory studies the behavior of dynamical systems that are highly sensitive to initial conditions—an effect which is popularly referred to as the butterfly effect. Small differences in initial conditions (such as those due to rounding errors in numerical computation) yield widely diverging outcomes for such dynamical systems, rendering long-term prediction impossible in general).[1] This happens even though these systems are *deterministic*, meaning that their future behavior is fully determined by their initial conditions, with no *random* elements involved.[2] In other words, the deterministic nature of these systems does not make them predictable.[3, 4] This behavior is known as deterministic chaos, or simply *chaos.* (Wikipedia, 2013)

NOTES

1. Kellert, S. H. (1993). *In the wake of chaos, unpredictable order in dynamical systems* (p. 32). Chicago, IL: University of Chicago Press.
2. Kellert (1993, p. 56)
3. Kellert (1993, p. 62)
4. Werndl, C. (2009). What are the new implications of chaos for unpredictability? *The British Journal for the Philosophy of Science, 60*(1), 195–220. doi: 10.1093/bips/oxn053

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CHAPTER 4A

MATERIALS REQUIREMENTS PLANNING (MRP)

NAME AND BRIEF DEFINITION

Material Requirements Planning (MRP)—A set of techniques that uses bill of material data, inventory data, and the master production schedule to calculate requirements for materials. It makes recommendations to release replenishment orders for material. Further, because it is time-phased, it makes recommendations to reschedule open orders when due dates and need dates are not in phase. Time-phased MRP begins with the items listed on the MPS and determines (1) the quantity of all components and materials required to fabricate those items; and (2) the date that the components and material are required. Time-phased MRP is accomplished by exploding the bill of material, (Blackstone 2013)

The original MRP was a technique for planning purchase orders and manufacturing orders to meet the requirements defined by the master production schedule (MPS). Previous techniques were based on replenishment—replacing what was used in the past. MRP was forward-looking; it based requirements on a forecast of future demand. See Table 4A.1 for a fuller explanation of the MRP process (Turbide, 1995).

Objectives (Reasons for Adopting Program)

The primary objective of MRP was to plan the production and purchasing requirements to meet forecasted demand and inventory requirements,

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Table 4A.1. Basic Description of Materials Requirements Planning (MRP)

MRP Basics

Material requirements planning (MRP) represented a striking departure from the way materials were planned before its introduction in the 1960s and early 1970s. Most earlier approaches were replenishment systems—new supplies of components and materials were ordered to replace those that had been used up. The simplest example of this is "order point" systems: when the supply on-hand reaches a pre-set minimum quantity, a replenishment order is launched. Order point takes many forms—informal, card files, 2-bin systems, and computer applications.

By contrast, MRP looks forward and only brings in materials when there is a future need. MRP must have a target, called a master production schedule (MPS), which consists of planned manufacturing orders for sellable items in response to customer orders, forecasts, or a combination of the two. MRP starts with the MPS and works its way down through the bill-of-material and backward in time, laying out a series of activities—purchase orders and manufacturing orders—that will bring in the materials needed at the proper time. Here are the four planning steps:

Gross Requirements—To arrive at the total number of components required (gross requirements), the planned quantity of parent items is multiplied by the quantity of each of its components. The assumed "need" date for these components is the start date of production for the parent item.

Net Requirements—Gross requirements are checked against the expected available quantity of each component on the date of need. Available quantity is today's on-hand quantity plus expected receipts minus expected usage between today and the need date. The difference between gross requirements and available quantity is net requirements. If a shortage is identified, planning proceeds to steps three and four.

Order Planning—MRP systems provide a variety of lot-sizing rules that are applied at this step. They include minimum order quantities, economic order quantity calculations, and days-of-supply. At this stage, we know how much to order, and when it is needed (due).

Lead time offsets—The system then considers the time required to manufacture, if necessary, and ship each component (the lead time). Subtracting a component item's lead time from its due date provides the date when the acquisition activity must be started.

Source: Adapted from Turbide (1995, p. 28).

both in timing and quantity. First, the demand for independent demand items had to be determined. Independent demand items are the finished goods items where demand for one item is physically different from the demand for another item. Examples are automobiles and refrigerators.

Once a demand forecast was available for the independent demand items, it is possible to calculate the demand for dependent demand items. Dependent demand items are those component parts and subassemblies that were an integral part of the independent demand items. For an automobile, dependent demand items were brake systems, steering wheels and the other items that are required to assemble an automobile. For a refrigerator, dependent demand items included compressors and light bulbs.

MRP is designed to calculate both how many and when the component parts must be available in order to finish the completed independent demand items on time. It is expected that this careful planning of requirements will result in greater availability of parts when needed and, at the same time, reduce the amount of inventory on hand with no requirement. Consequently, stockout costs and inventory carrying costs can both be reduced.

History (Time Line, Reasons Originated, Principal Developers)

MRP was first commercially available in the 1950s. Up until that time, companies had done this planning manually. For example, in the furniture industry, a demand forecast for the line of products to be produced for the season was prepared as a result of feedback and orders from the furniture show. From that forecast, a planner would determine wood requirements to make the furniture; another would determine the hardware needed; and a master scheduler would prepare a sequence in which the items would be made. It was a time consuming process.

When computers became available with sufficient processing capacity, it was possible to see how the manual process could be computerized. MRP/ERP systems were first introduced by George Plossl and Joseph Orlicky in the late 1960s. Oliver Wight contributed the evolution to MRP II, to include more than the factory production and material needs. ERP evolved with the change in hardware and software capability and interface interpretations between software (Wikipedia 2010).

Figure 4A.1 shows the number of articles published about basic MRP. The number of articles peaked in the early 1980s and declined after the introduction of MRP II and ERP. In the earlier years, the split between trade and scholarly was about equal; in recent years, most of the articles are not about MRP but simply a reference to it as the forerunner of later developments. For a fuller description of the development of MRP and its successor programs—MRP II and ERP—see the book by Ptak and Schragenheim (2004).

Expected Benefits (Tangible and Intangible)

MRP made it possible to reduce inventories and improve customer service by increasing on-time and complete deliveries. It also made it possible to improve operator and equipment efficiency and utilization by

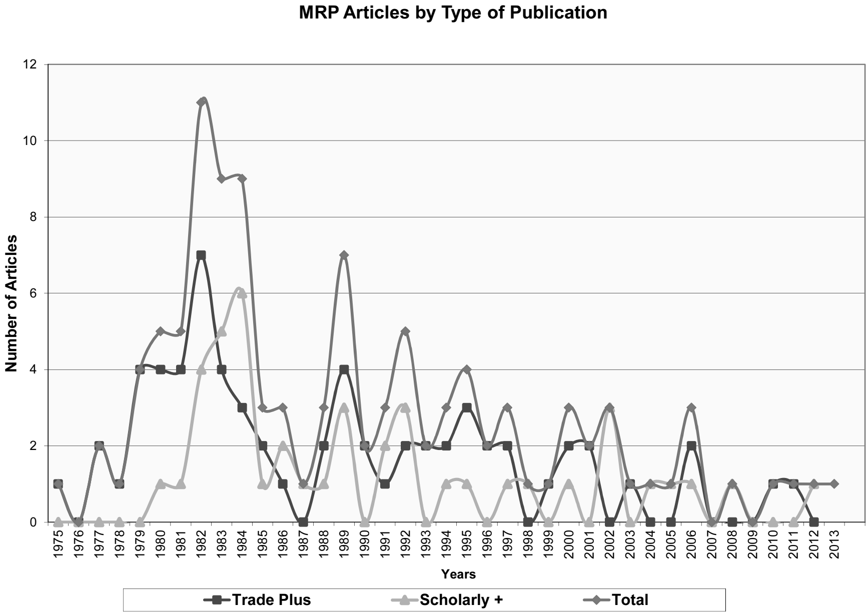

Figure 4A.1. Number of articles about Materials Requirements Planning (MRP).

reducing the number of interruptions to the production process, such as in rush orders.

MRP also made it possible to better allocate manufacturing resources and to choose among make-or-buy alternatives. This led some companies to review product offerings and lead time commitments to establish more profitable product lines and more realistic delivery commitments.

MRP came to represent an approach to careful and systematic planning. It was heralded as a professional way to manage the manufacturing process. Today, the descendants of MRP—MRP II and ERP—are in the forefront of most manufacturing operations.

Barriers to Acceptance

MRP did not represent a new concept in planning; however, the computer did offer a better way of doing the planning. To this extent, it was willingly accepted by most of the people who had been doing this operation manually.

The obstacles to MRP were very tangible. It was a complex system that cost a great deal of time and money to implement. Much of the cost resulted from the need to build accurate and complete bills of materials (BOM) for each product, and to build accurate and complete inventory records for each item. Many of the more complex products, such as automobiles and farm machinery, contained thousands of dependent demand items. New standards for accuracy of records were established.

In addition, it took a lot of computer time to run the BOM explosion (calculate the demand for each item). Some companies incurred run times of 24–36 hours, so the MRP could only be computed on weekends. It represented a massive demand on computer resources.

In some cases, the generic software did not fit the processes of the potential user. To resolve the difference required either a change in the way of doing business or a modification of the software. Either option was an obstacle that could cause considerable delay or increased costs.

Even when successfully installed, MRP had some severe limitations. First, it used infinite capacity planning (i.e., it assumed that capacity would be available to produce or purchase all of the item requirements). As a result, shop floor supervision had to take the MRP requirements and adjust them to the capacities of the shop. Second, the lead times used in calculating the time for items to be started and finished were fixed and did not always reflect the true situation in the plant operation.

Another development that slowed the growth of MRP systems was the arrival of the Just-in-Time (JIT) concept. Advocates of JIT claimed that if the production process could be adapted to a JIT process in which a more consistent flow of goods would simplify the production planning process to the point that the more formal planning provided by MRP would be redundant. While effective implementation of JIT did simplify the production process, most companies found that MRP could be viewed as a planning tool and JIT as a shop floor execution tool. With this perspective, MRP became a complement to JIT.

Implementation Approach

Implementation of the system included the following major steps:

Justify the cost/benefits of installing MRP. The major costs were for the system hardware and software. Implementation costs included consulting services and internal payroll costs for the employees involved in the implementation. As in most systems implementations, the costs were tangible, while the benefits—reduced inventory, improved delivery performance and increased information value—were less tangible. Consequently, some companies had to move ahead with their MRP programs based on a combination of some expected savings and the additional confidence that it appeared to be a logical transition to make.

Select the MRP software to be used. Early MRP systems were designed for specific companies or industries; however, later versions incorporated “best practices” and required modification to fit individual company needs.

Introduce and gain support of management and employees. While early applications were directed primarily at the production planning process, it had some effect on other functions such as engineering and production, so it was important to involve those functions early in the system project to assure a smooth implementation later.

Build the internal data sources. To operate effectively, MRP systems required at least four key data sources for each product, which were used as inputs to the planning process. These included bills of material for all of the items in the finished product; process, or route, sheets, showing the sequence of operations to make the product; inventory records for each item being planned, and an estimate of lead times to perform each operation or secure the item from an outside supplier. These data sources not only had to be complete; they had to be accurate if the MRP process was to be meaningful.

Implement the system. Implementing the MRP system was a major undertaking and required a project management approach. It usually involved a pilot program in which the system was installed in a selected application, to test the hardware/software functioning and to identify the benefits and problems associated with the implementation. It could also be used as an example to the rest of the organization.

Train the employees. Training usually takes place during the implementation. Employees have to be shown not only how to operate the system, but how to identify potential problems and either correct them or contact the appropriate technicians to get them resolved.

Resolve the problems. During implementation, all major systems incur problems and they must be resolved quickly and effectively to prevent erosion of the system’s integrity in the minds of the employees and any outside contacts—suppliers and customers—affected.

Maintain the system. Once it is running smoothly, it is still important to identify, or prevent, disruptions to the system’s operation. As time passes, the software vendor may come up with additions or modifications to the system that will need to be seamlessly integrated to the operating system.

Sometimes, the implementation process could take months. Often, a lot of work had to be done in getting ready to use the system, so that months could pass in the project schedule before any tangible benefits could be expected.

Future

MRP was one of the earliest computer-based operations management systems. While a pioneer, it has since been replaced with Manufacturing Resource Planning (MRP II) and Enterprise Resource Planning (ERP)—programs to be described in the sections under their names. While many managers still refer to their system as "MRP," they are most likely using a newer version of software that more properly falls under the heading of MRP II or ERP systems.

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Wikipedia, *Materials Requirements Planning*, accessed January 4, 2010.

CHAPTER 4B

MANUFACTURING RESOURCE PLANNING (MRP II)

NAME AND BRIEF DEFINITION

Manufacturing Resource Planning (MRP II)—A method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning in dollars, and has a simulation capability to answer what-if questions. It is made up of a variety of processes, each linked together: business planning, production planning (sales and operations planning), master production scheduling, material requirements planning, capacity requirements planning, and the execution support systems for capacity and material. Output from these systems is integrated with financial reports such as the business plan, purchase commitment report, shipping budget, and inventory projections in dollars. Manufacturing resource planning is a direct outgrowth and extension of closed-loop MRP (Blackstone, 2013). The basic materials requirements planning program (MRP) was described under the program by that name.

Objectives (Reasons for Adopting Program)

The primary objective of MRP II was to extend materials requirements planning (MRP) and connect the operations planning functions with the marketing forecasts and the financial reports. It was an attempt to make

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planning more realistic by incorporating the marketing and financial inputs and constraints in the total company plan.

The newer software packages also included improvements and features that were not included in the original MRP software. MRP II is a closed-loop system that links a number of business management applications to the production planning process of materials requirements planning (MRP). Some of these added applications include capacity planning; customer service (order entry, finished goods inventory, forecasting, and sales analysis); execution systems (production control, purchasing, inventory, and product data management), and financial functions (cost accounting, general ledger, payables, receivables, and payroll) (Turbide, 1995).

History (Time Line, Reasons Originated, Principal Developers)

Articles about MRP II began appearing in the early 1980s and continued until about 2000. There were articles about both MRP and MRP II and it appears that the terms were used interchangeably in the literature although there was a distinct difference in the content of the software and the reach of the programs within a company. Once the ERP articles began in the early 1990s, the number of MRP and MRP II articles declined. Figure 4B.1 shows the number of total articles published, along with the split between trade magazines and scholarly journals.

An article in 1995 viewed MRP II in this way: "To the great surprise of many, manufacturing resource planning (MRP II) is still the dominant application software structure for today' manufacturing management. MRP II remains basically unchanged despite the fact that the idea dates back more than thirty years, and packaged software products for MRP have been around since the 1970s" (Turbide, 1995).

Expected Benefits (Tangible and Intangible)

MRP focused primarily on the shop floor. MRP II attempted to extend the applicability of the system to include Marketing's demand forecast as input to the production planning process. It also linked with the accounting and financial functions to report production results to be included in the financial reports.

This represented a major step in linking functions within a company. While limited, it was the forerunner of more extensive linking systems to come. MRP II is designed to be a total information system that shares

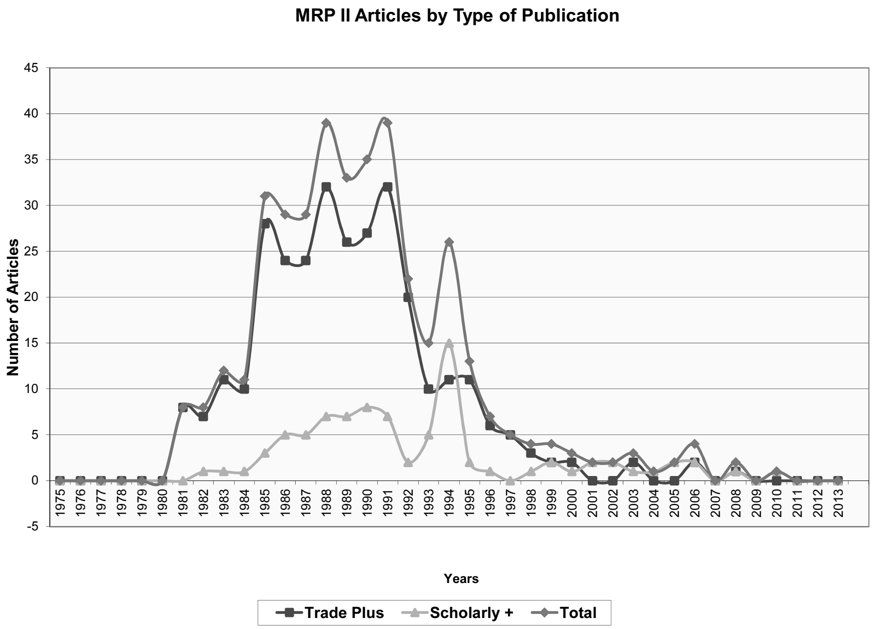

Figure 4B.1. Total number of MRP II articles.

data among the various applications for their mutual benefit (Turbide, 1995).

Barriers to Acceptance

By linking the information flow within a company, MRP II raised the awareness of the interdependence of functions within a business. While most managers were aware of the relationships, it was only when the numbers had to fit together that the need for close working relationships became a reality. While there may have been some resistance to the new system, few could dispute the logic inherent in the system.

The major barriers were probably the cost of the new bigger and better systems. Few companies had the inside talent or inclination to design a system as large and complex as MRP II. However, the new software was expensive and required a long implementation period, even for companies with active MRP systems in place.

Computer compatibility problems also began to arise. Legacy systems that had been adequate in the past now were being forced out by the new system and employees not only had to learn the new system but also work out the kinks in it as they learned. MRP II exposed many of the subtle differences in the way companies handled different administrative processes. These differences led to the need to either change the way things were being done to fit the system (designed around best practices) or change the system to fit the way things were being done. To the consternation of many, the system often won out.

The appearance of the Just-in-Time (JIT) approach was also beginning to become popular. This approach stressed the need for simplicity and some suggested that JIT and MRP II were mutually exclusive—you choose one or the other. At times, they were presented as the American way (MRP) or the Japanese way (JIT). In addition, some consultants choose sides and emphasized either MRP or JIT as the way to go. It wasn't until some years later that the consensus shifted and the position that MRP and JIT were complementary as planning (MRP) and execution (JIT) programs.

Some companies found that the MRP II system had more features than they needed or could justify implementing. As a result, the full potential of some MRP II systems remained dormant. While the increased complexity of the system presented implementation problems, the logic of the software worked. In viewing companies who obtained only partial success, some consultants, who observed multiple implementations, identified the main problem as one of people issues, including:

- Lack of top management commitment
- Failure to manage change, including helping people to accept change
- Failure to adapt the organization and its processes to exploit the system's capabilities
- Failure to provide sufficient user training and education (Turbide, 1995)

Implementation Approach

For companies who already had a functioning MRP system, the MRP II implementation was concerned primarily with setting the interfaces with the marketing and financial functions. While some changes may have been made in the demand forecasting procedures, it was unlikely that changes would be made in accounting or financial processes. So it was a case of how to link the functions together.

For companies who did not have an active MRP system, they had a large implementation project to contend with. They had to do all of the steps shown in the MRP implementation, plus build the interfaces described in the preceding paragraph.

Implementation included the following major steps that were similar to those described for MRP:

Justify the cost/benefits of installing MRP. The major costs were for the system hardware and software. Implementation costs included consulting services and internal payroll costs for the employees involved in the implementation. As in most systems implementations, the costs were tangible, while the benefits—reduced inventory, improved delivery performance and increased information value—were less tangible. Consequently, some companies had to move ahead with their MRP programs based on a combination of some expected savings and the additional confidence that it appeared to be a logical transition to make.

Select the MRP software to be used. Early MRP systems were designed for specific companies or industries; however, later versions incorporated "best practices" and required modification to fit individual company needs.

Introduce and gain support of management and employees. While early applications were directed primarily at the production planning process, it had some effect on other functions such as engineering and production, so it was important to involve those functions early in the system project to assure a smooth implementation later.

Build the internal data sources. To operate effectively, MRP systems required at least four key data sources for each product, which were used as inputs to the planning process. These included bills of material for all of the items in the finished product; process, or route, sheets, showing the sequence of operations to make the product; inventory records for each item being planned, and an estimate of lead times to perform each operation or secure the item from an outside supplier. These data sources not only had to be complete; they had to be accurate if the MRP process was to be meaningful.

Implement the system. Implementing the MRP system was a major undertaking and required a project management approach. It usually involved a pilot program in which the system was installed in a selected application, to test the hardware/software functioning and to identify the benefits and problems associated with the implementation. It could also be used as an example to the rest of the organization.

Train the employees. Training usually takes place during the implementation. Employees have to be shown not only how to operate the system, but how to identify potential problems and either correct them or contact the appropriate technicians to get them resolved.

Resolve the problems. During implementation, all major systems incur problems and they must be resolved quickly and effectively to prevent erosion of the system's integrity in the minds of the employees and any outside contacts—suppliers and customers—affected.

Maintain the system. Once it is running smoothly, it is still important to identify, or prevent, disruptions to the system's operation. As time passes, the software vendor may come up with additions or modifications to the system that will need to be seamlessly integrated to the operating system.

As with MRP, the implementation process could take months. Often, a lot of work had to be done in getting ready to use the system, so that months could pass in the project schedule before any tangible benefits could be expected.

Future

The idea of designing information systems that linked different functions together was a new and attractive idea. While MRP II led the charge, it remained for Enterprise Resource Planning (ERP) systems to solidify this position among the leaders in business organizations.

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CHAPTER 4C

ENTERPRISE RESOURCES PLANNING (ERP)

NAME AND BRIEF DEFINITION

Enterprise Resources Planning (ERP) System—(1) An accounting-oriented information system for identifying and planning the enterprise wide resources needed to take, make, ship, and account for customer orders. An ERP system differs from the typical MRP II system in technical requirements such as graphical user interface, relational database, use of fourth-generation language, and computer-assisted software engineering tools in development, client/server architecture, and open-system portability. (2) More generally, a method for the effective planning and control of all resources needed to take, make, ship, and account for customer orders in a manufacturing, distribution, or service company. (Blackstone, 2013)

The advanced capability of computers enables ERP systems to do more than the traditional MRP II systems in the use of relational databases; fourth-generation languages; integrated computer-aided engineering tools, such as product data managers (PDMs); and open-system portability to integrate systems such as advanced planning and scheduling (APS), finite scheduling systems, and manufacturing execution systems (MES) (Ptak & Schragenheim, 2004).

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Objectives (Reasons for Adopting Program)

The primary purpose of ERP was to extend the MRP II concept of linking functions. The aim of ERP was to link all of the functions of an organization into a tightly integrated network with a central database and real time information flow to and from the various functions of the organization.

An ERP system covers the following common functional areas. In many ERP systems these are called and grouped together as *ERP modules*:

- Financial accounting: General ledger, fixed asset, payables, receivables, cash management, financial consolidation
- Management accounting: Budgeting, costing, cost management, activity based costing
- Human resources: Recruiting, training, payroll, benefits, 401K, diversity management, retirement, separation
- Manufacturing: Engineering, bill of materials, work orders, scheduling, capacity, workflow management, quality control, manufacturing process, manufacturing projects, manufacturing flow, product life cycle management
- Supply chain management: Supply chain planning, supplier scheduling, order to cash, purchasing, inventory, product configurator, claim processing
- Project management: Project planning, resource planning, project costing, work break down structure, billing, time and expense, performance units, activity management
- Customer relationship management: Sales and marketing, commissions, service, customer contact, call center support—CRM systems are not always considered part of ERP systems but rather Business Support systems (BSS). Specifically in telecom scenario
- Data services: Various “self-service” interfaces for customers, suppliers and/or employees (Wikipedia, 2013)

While ERP systems retain the basics of MRP II, the availability of advanced technology is making it possible to extend the scope of ERP to all functions of an organization and even beyond to selected participants in the supply chain. As Ptak and Schragenheim (2004) point out, “A nimble supply chain is essential as a competitive tool as we move into the next millennium. A successful ERP implementation is a critical link of that chain.”

History (Time Line, Reasons Originated, Principal Developers)

Inventory management techniques first appeared soon after World War I. F. W. Harris published a paper on inventory management in which he introduced the economic order quantity (EOQ) (Harris, 1913). Reorder point systems of replenishment followed, along with a variety of algorithms for determining order quantities. However, each item was viewed as an independent demand item, without regard to its relationship with lower level components or higher level assemblies. MRP introduced the distinction between independent demand items (the final assembly or parent) and dependent demand items (subassemblies or components, the children).

MRP came into prominence in the mid-1960s, closed-loop MRP in the early 1970s, MRP II at the beginning of the 1980s and ERP at the beginning of the 1990s (Ptak & Schragenheim, 2004).

"Understanding the history and evolution of ERP is essential to understanding its current application and its future. ERP is not just MRPII with a new name. It is the next logical sophistication level in an evolutionary series of computer tools that began in the 1950s." (Ptak & Schragenheim, 2004).

A number of software development companies were around at the beginning of the ERP beginnings. Although many did not last long, some of the more durable ones included Peoplesoft, A. G. Edwards, SAP and Oracle. SAP became the leader worldwide. Today, SAP and Oracle, who acquired both Peoplesoft and A. G. Edwards, are the primary suppliers of ERP software.

One of the factors that gave ERP systems a large boost in sales was the "millennium bug"—the concern about what would happen to computer dates when the time changed from December 31, 1999, to January 1, 2000. ERP software had the answer; it provided four spaces for the year and avoided all of the concern about legacy systems with only two digits for the year. As a result, unknown numbers of companies installed ERP systems to avoid the potential disaster when moving into a new millennium. It is also of interest to note that the number of articles published about ERP peaked in 1998 and 1999, just before the turn of the century. Figure 4C.1 shows the total number of articles published about ERP.

Early enterprise resource planning (ERP) systems were not primarily focused on the supply chain. Their initial focus was to execute and integrate such internally-oriented applications that support finance, accounting, manufacturing, order entry, and human resources. Having got their internal operations somewhat integrated, many organizations have

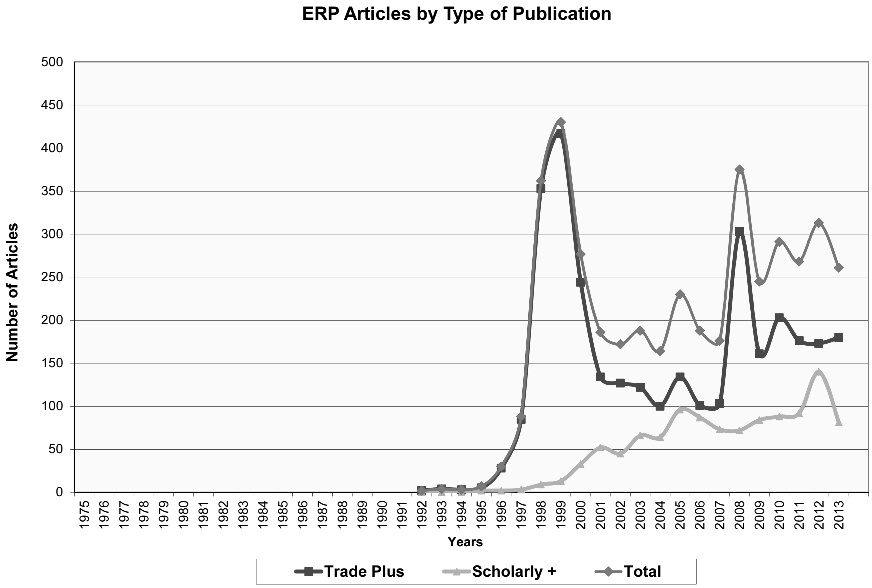

Figure 4C.1. Total number of ERP articles.

moved on to address the need to extend ERP along their supply chain (Davenport & Brooks, 2004).

Figure 4C.1 shows the total number of articles published, separated by trade magazines and scholarly journals. This is a search limited to references to both Enterprise Resource Planning and ERP in the abstract of articles only. The first articles about ERP were published in the early 1990s; prior to that, the articles would have referenced MRP. As expected, there is a peak of interest immediately before 2000, and a decline after the Y2K concerns were gone. The major emphasis in recent years has been in extending ERP linkages between supply chain participants and extending the use of ERP into new markets.

Expected Benefits (Tangible and Intangible)

One of the benefits from implementing an ERP system is that a company must compare its present procedures with those built into the best practice procedures of the ERP system. Because it is difficult to change the ERP programs, it is sometimes easier to change the company's procedures to fit the system. Assuming the system procedures are best practices, there is a potential to make improvements that result in lower costs and higher quality.

Another benefit is that information begins to flow among the functions in a company so that the information used is consistent, more accurate and more relevant to the needs of the users. Production and purchasing use the marketing forecast and don't have to make up their own in order to prepare the production and purchasing plans. The inventory plan reflects the inputs from both the operations group and the financial group.

Because of the need to collaborate on the plans and reports, the different functions of the organization learn to work together in a more effective way. They should begin to recognize that together they can achieve better results.

At some point, the company should begin to realize tangible benefits, such as reduced costs, especially in administrative procedures; improved quality, as in reduced administrative errors; and reduced response times because of the coordinated efforts of the various groups within the company.

The improvement in information reliability should help improve customer service by providing customers and suppliers with more reliable and consistent information. As companies increase their exchange of information, the output from ERP systems should become more robust.

Barriers to Acceptance

The major barrier to acceptance is the initial investment cost of the software package and the accompanying installation costs. Most companies need consulting help in installing an ERP system and there is also an ongoing annual maintenance cost. Some ERP implementations take two to five years and cost from $50 to $500 million. Since saturating the ERP market for large companies, software companies are now offering smaller versions to smaller companies.

Another major barrier is the resistance of the company management and employees to major change, and an ERP system represents a major change. Employees at all levels are affected and, because of its universal applications, there are ramifications throughout the organization. The long implementation time with few early tangible benefits makes this an arduous process.

Companies may be partially to blame for employee resistance because they are sometimes reluctant to spend the time and money it takes to educate their employees about the system. In addition to on-the-job training, employees should be informed about the system benefits, implementation requirements, and effect on job security and job change. While ERP systems are advanced technologies, their eventual success depends on people. Most ERP failures can be traced to the failure to educate implementation team members and users (Ptak & Schragenheim, 2004).

A more recent barrier is the reduction in the number of software vendors. As smaller companies are acquired by larger companies, it raises the specter of reduced, or nonexistent, ongoing support. Will the surviving companies continue to support the software developed early in the ERP development period, or will they withdraw support of older packages?

Another recent development is the tendency of companies to be more selective in their software purchases. In the 1990s, the preferred approach was to move toward integrated software. Following 2000, many companies have moved to a "best of breed" approach, in which they mix and match software applications. This has resulted in an approach called service-oriented architecture (SOA), a program to be discussed separately.

Implementation Approach

Implementation of an ERP system is a major project and is fraught with difficulties. Bancroft, Seif and Sprengel (1998) describe the implementation of SAP's R/3 system. They divide the multiyear project into the phases outlined below. For a more detailed listing of specific steps in the implementation process, see the complete article.

- Phase 1: Focus
- Phase 2: Create the As Is Picture
- Phase 3: Create the To Be Design
- Phase 4: Construction and Testing
- Phase 5: Implement the System

However, while many organizations consider the introduction or enhancement of an ERP solution, they are often unprepared to use project management as a technique to facilitate the implementation. Deploying a Project Management Office (PMO) streamlines and facilitates the ERP implementation process. Companies that leverage the strength of a PMO can mitigate risk, minimize costs, and expect smoother implementations. Establishing solid project management techniques through the use of a PMO can provide the needed structure to successfully guide companies through otherwise murky implementations (Axam & Jerome, 2003).

A number of factors are critical to ERP implementation success: ERP teamwork and composition, change management program and culture, top management support; business plan and vision; business process reengineering with minimum customization; project management; monitoring and evaluation of performance; effective communication; software development, testing and troubleshooting; project champion; and appropriate business and IT legacy systems.

Some of the reasons for ERP implementation failures include:

- Poor leadership—Top management must be fully committed to the program
- Poor project management—Project managers are not empowered or lack skills
- Poor data quality—Data is inaccurate, incomplete, inconsistent, inaccessible or doubtful
- Unrealistic expectations—Too high for results; too low for resource requirements
- Poor training program—Lack of component in-house trainers; inadequate commitment
- User resistance—Change is a difficult transition for most
- Poor fit between ERP system and organization—Adaptation is necessary for success (Shaul & Taber, 2013)

Future

ERP systems will continue to evolve as information technology continues to advance. ERP is now considered to be necessary for running a business, and for connecting with other enterprises in a supply chain. However, one of the challenges for ERP vendors is how to extend their use to smaller companies. Initially, ERP systems have been installed in large manufacturing companies. A key premise of ERP systems is the underlying, sometimes unstated, but often implicitly promoted notion that ERP systems represent best business practices. At present, ERP focuses mainly on structured transaction data in organizations. As companies move to a more Web-based multimedia world, enterprise-wide information is also likely to expand to include multimedia documents such as engineering drawings, scanned documents, and audiovisual product descriptions (Kumar & Hillegersberg, 2000).

ERP systems are well established in the current business environment. Their major limitation is that they were originally designed to provide integration within a specific organization. In the future, companies will need systems that help them link with their customers and suppliers, along the supply chain. The major ERP software suppliers are working to provide these software extensions in the form of modules that connect with the existing ERP systems. Two of the major extensions are Customer Relationship Management (CRM) and Supplier Relationship Management (SRM).

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CHAPTER 4D

CRITICAL PATH METHOD (CPM)

NAME AND BRIEF DEFINITION

The critical path method (CPM) is a subset of the broader topic of project management. A project is a one-of-a-kind endeavor to produce a tangible good (such as a building) or provide a unique service (an around-the-world tour), as opposed to the repetitive production of standard, or at least very similar, goods (a household appliance such as a dishwasher) or services (checking out at the local grocery store). A project consists of a series of individual tasks that must be performed in a prescribed sequence in order to complete the total job. A project usually spans days or weeks and involves the work of human participants with varying skills and assignments. A project manager is required to coordinate the work of multiple parties to assure the tasks are done correctly, in the right sequence and, at the right time, to assure completion of the total project as planned.

Project management—The use of skills and knowledge in coordinating the organizing, planning, scheduling, directing, controlling, monitoring, and evaluating of prescribed activities to ensure that the stated objectives of a project, manufactured good, or service are achieved (Blackstone, 2013).

Critical path method (CPM)—A network planning technique for the analysis of a project's completion time used for planning and controlling the activities in a project. By showing each of these activities and their

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associated times, the critical path, which identifies those elements that actually constrain the total time for the project, can be determined. See: critical chain method, network analysis, critical activity, critical path (Blackstone, 2013).

Preparing a project plan requires the following information:

- A list of every activity or event to be completed in the project
- The time required to complete each activity, with the given amount of resources
- The precedence relationship among every activity
- The resources available
- The cost of "crashing" for each activity and the amount of time that could be crashed.

Objectives (Reasons for Adopting Program)

The basic objective of most businesses is to transform inputs into outputs. When the transformation process is relatively simple, employees learn to perform these tasks from memory or with simple instructions. However, as the transformation process becomes more complex or requires extensive customization, project plans become necessary. Table 4D.1 shows a continuum from the most routine to the most unique. At the left hand side are tasks that are relatively simple with only a few steps required to complete. They can be committed to memory or, in some cases, are so routine that individuals perform them without even consciously thinking about each step in the process.

As we move across the continuum, the tasks, and combinations of tasks, become more involved. The individual task becomes more complex, requiring additional thought to perform, and the number of employees involved in coordinating these tasks increase, adding to the complexity of the entire process. On the right hand side of the figure, the combination of tasks and participants becomes so complex that a detailed project plan is essential for the successful completion of the project. At some point, it is necessary to move from informal instructions to a more formal planning process. Project planning, and more specifically the critical path method of project planning, are examples of these more formal planning processes.

There are several types of organizations that have a need for project planning:

Table 4D.1. A Continuum of Activities From Routine to Unique

	Routine (Not a Project)		*Project Plans Required*		
Time Horizon	*Minutes*	*Hours*	*Days or Weeks*	*Months or Years*	*Years*
Parties involved	Single or limited number of persons	Multiple persons within the same organization	Multiple persons with common interests and knowledge	Multiple persons, not all with complete understanding	Multiple persons in multiple organizations, with incomplete knowledge
Description	Simple and repetitive tasks with a high level of understanding by participants	Many simple or complex tasks that have been defined and participants are trained to perform	Many tasks that require specific modifications to meet customer requirements	The objective is clear and all tasks can be well defined; similar to previous projects	Objective may be known, but not all tasks have been identified
Example	Checkout at a grocery store	Assembling a standard automobile with minor customizing	Installing a materials handling system for a distribution center	Building a bridge across a river	Developing a cure for cancer
Documentation required	None, performed from memory	Drawings or instructions available but rarely needed	Drawings or instructions available as needed	Formal project plan required; may require some revisions	Extensive documentation of progress and revisions

- *Companies that design and implement projects as a part of their operation.* An example is construction firms—companies that manufacture houses, commercial buildings, bridges, roads, and the like. They usually have in-house skills to do their own project planning and use the plans on a regular basis to monitor their progress.
- *In the service arena, nonprofit aid organizations,* such as the American Red Cross, also do projects on a regular basis when they set up emergency operations for hurricane-damaged areas. Another example would be a retail chain that opens a new store. In this example, a series of unique steps or processes must be accomplished before the store is ready for operation. Typically, a special

training manager is brought in to facilitate the opening of the store by working with the local manager and employees. Once the store is up and running, the training manager moves to a new store opening.

- *Companies that have an occasional project that is not normally a part of their day-to-day business*. Examples could include the acquisition of a company, locating and building a new manufacturing plant, or outsourcing a major portion of their operations to an offshore supplier. Often, even large companies, may not have the in-house capabilities to plan a major project and require the services of companies that provide the needed expertise.
- *Companies that sell project planning services*. These companies are consultants to other companies and provide project planning training, software, and consulting services to companies that have less knowledge in project planning.

Almost every organization, profit and nonprofit, has the need for project planning at some time during their existence.

History (Time Line, Reasons Originated, Principal Developers)

Projects have existed since the beginning of civilization. The earliest architects and engineers were among the first to construct major projects such as the pyramids, irrigation systems and roads. In the modern era, it was immediately after World War II that organizations began to systematically apply project management tools and techniques to complex projects.

Prior to World War II, Henry Gantt, a disciple of Frederick Taylor, developed a way of showing the elements of a project on a time scale, so it was possible to plan and track the progress of each activity in the project. Refinements of this approach became known as the Gantt Chart, which is still used today for less complex projects.

After World War II, the nature of projects changed considerably, as both government and industry found they needed more sophisticated project management techniques. It was during this time that complex network diagrams called Program Evaluation and Review Technique (PERT) charts and the critical path method (CPM) were introduced. The consulting firm Booz-Allen & Hamilton, developed PERT as part of the United States Navy's (in conjunction with the Lockheed Corporation) Polaris missile submarine program (Booz Allen Hamilton, 2011). The DuPont Corporation and the Remington Rand Corporation developed CPM as a tool to help in managing plant maintenance projects. These tools gave managers greater control over complex projects and helped to develop common management standards and practices. The Project Management Professional (PMP) certification is now one of the top certifications in the world. Today, many government contracts are beginning to require project managers to have the PMP credential (LaBrosse, 2007).

As project-scheduling models were being developed, technologies for project cost estimating, cost management, and engineering economics were evolving, with pioneering work by Hans Lang and others. In 1956, the American Association of Cost Engineers (now AACE International; the Association for the Advancement of Cost Engineering) was formed by early practitioners of project management and the associated specialties of planning and scheduling, cost estimating, and cost/schedule control (project control). AACE continued its pioneering work and in 2006 released the first integrated process for portfolio, program and project management (TCM Framework, 2011).

The International Project Management Association (IPMA) was founded in Europe in 1967 as a federation of several national project management associations (Koushalt, 2007). IPMA maintains its federal structure today and now includes member associations throughout the world. IPMA offers a Four Level Certification program based on the IPMA Competence Baseline (ICB) The ICB covers technical competences, contextual competences, and behavioral competences (IPMA, 2011).

In 1969, the Project Management Institute (PMI) was formed in the United States. PMI publishes *A Guide to the Project Management Body of Knowledge* (PMBOK Guide), which describes project management practices that are common to "most projects, most of the time." PMI also offers multiple certifications (Harrison, 2004).

Early project planning methods were designed for different purposes. The CPM method was designed for construction projects, where projected work times and resources required were predictable within narrow ranges. Consequently, these projects were activity-oriented. The PERT method was initially designed for use with the development of the Polaris submarine, with its need for technology innovations, even inventions, and dependence on uncertain time estimates and resource requirements. As a result, the project was event-oriented—when does the desired outcome become a reality? Although the project networks for PERT and CPM may appear similar, the projects they describe have completion times that vary because of the probabilities used in the PERT method.

Critical Path Method management articles appeared first in the 1960s and remained fairly constant through the 1970s and early 1980s. The number of scholarly articles began to increase about 1985, decreased to a low in 1999 and has been on a somewhat upward slope since. Figure 4D.1

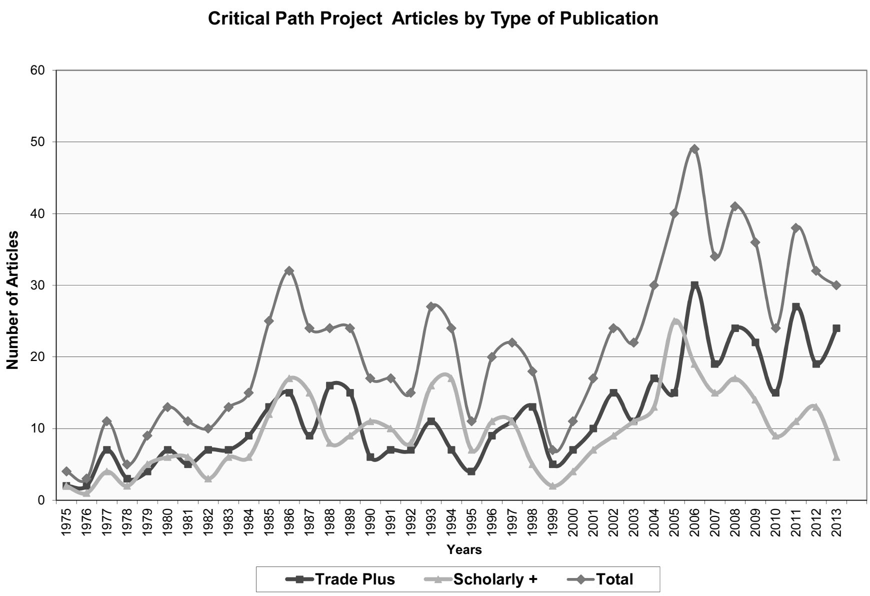

Figure 4D.1. Number of articles written about Critical Path Method.

shows this pattern with articles about equally divided between trade and scholarly journals. Of course, the number of articles is not exceedingly high compared to other management programs in this book. Nonetheless, the life cycle of project management seems well established.

Expected Benefits (Tangible and Intangible)

The primary benefit of using project management methodologies is that they help ensure the project will be completed successfully, which means on time, within the projected costs and with all activities completed as planned. The use of CPM has now expanded beyond strict schedule applications into the field of cost-control. The first uses of CPM were limited to project planning and control. After the initial planning phase, the relative value of CPM was greatly reduced. Expansion of the initial uses came in the areas of resource analysis and cost-on-schedule. Lately, a number of new and different applications have come into being, as modes of operation have been forced to adapt to new and special requirements. The tendency toward claims/arbitration/litigation in the settlement of construction disputes, the increased focus on maintenance, and the capability of computer systems to handle "what if" analysis have led to a greater use of CPM. In the area of contract disputes, "but-for" simulations, in which schedule performance is simulated without delays imposed on the participants, and "as-planned" impact analysis have become important (Glenn, 1985).

In addition to completing the project successfully, the organization improves its capabilities by enabling cross-functional teams to work together more effectively. As the level of collaboration increases, there is an increasing expectation that future projects can be even more successful. Empowered employees, operating within an organizational structure that encourages and facilitates horizontal communication not only within the company but also among other companies, can achieve remarkable results.

As organizations become more capable in defining, planning, and managing projects, they will be better prepared to deal with today's more complex environment; one that is moving from standard, high volume, products and services to unique, low volume, customization of products and services. This transition is generating the need for more projects as organizations attempt to deal with rapid changes in the marketplace. This means that organizations will find that project management approaches can be effective in areas not previously experienced, such as in offshore outsourcing and supply chain integration.

Even in regular line manufacturing, some companies find that added flexibility can be gained through the use of project management. Reliance on straight-line manufacturing strategies was prevalent until recently. However, in this era of flexible manufacturing, there is a need to schedule operations and work assignments to minimize time and cost. Project management can be extended to assembly sequencing and worker assignment through the development of dynamic analysis tools. Providing management with an accurate picture of the time and cost required by analyzing the resource requirements and activity durations is possible through project management. A shop-floor management system can provide extensive performance tracking capability enabling close control of production operations. The ability to provide real-time information on the status of the manufacturing process allows integration with other supporting areas, such as planning, inventory, and inspection (Huber, 1988).

Project management approaches make it convenient for organizations to compile and organize information that can be used in future projects. Knowledge management is becoming an imperative for many organizations and project management is an approach that is compatible with good knowledge management. Information is the medium by which these project management issues are understood and managed. The core of networking to information management is that of defining, structuring, and organizing information and the process of information feedback. The use of networking as a methodology for the management of information avoids such problems as: (1) duplication of effort; (2) loss of information integrity; (3) decreased productivity; (4) higher costs; (5) bad decisions; and (6) loss of market influence (Matthews, 1986).

Project management can provide a strategic advantage for a company. In assembling all of the capabilities to successfully complete projects, an organization develops a core competency in project management. Companies that can manage projects are in a better position to seize new opportunities, vacate losing positions, or otherwise navigate through transitional periods that require nontraditional approaches or actions. If they have the management insight, the organizational structure, the human resource talent and commitment, and the institutional memory to quickly plan and implement a change in direction, they will have a strong competitive advantage.

Barriers to Acceptance

Although the use of project management methodologies has proved useful over the years, there are reasons why companies may be reluctant, or even resistant, to using project management. There are four principal barriers: (1) it takes a commitment of time and resources; (2) it is difficult to implement successfully; (3) it is difficult to monitor and control; and (4) it is difficult to evaluate the results after the completion of the project.

A Significant Commitment is Needed

Before even starting, it takes a commitment on the part of management to begin the use of project planning methods. Project planning is time consuming and may require the disruption of normal operations in order to get the appropriate employees involved in the planning process.

Projects are Difficult to Plan

Even if management is committed to formal project planning, companies may find it difficult to actually do the planning. Planning even modest-sized projects requires considerable information that may not be readily available.

It also takes trained participants to develop an effective plan. Planners must understand the individual components of a plan and how to fit them together. It requires participants who understand the concept of tradeoffs, because it may be necessary to consider the relationship between activity time and resource commitment—the lower the resource commitment, the longer the activity time. They must also know how to use the planning tools available to them, specifically the software that is now essential for planning projects. Even the smallest of projects is now being implemented with PC software; with larger projects requiring specially designed software.

As a corollary to requiring trained participants, project planning requires the availability of cross-functional teams of employees. This is a characteristic of project planning; it can seldom be done by a single functional area; it requires input and participation by representatives throughout the organization.

The Plan Must Be Monitored and Controlled

Planning is important, but most projects fail because of the lack of follow-up to the original plan. With each step in the project, the use of resources in terms of time and cost must be compared to the original plan. Often, even small differences can have a significant effect on the final outcome, especially if the difference occurs along the critical path of the project. Here, it is important to analyze the causes of differences. Are they assignable to a specific cause, which can be corrected, or are they the normal variation in a process?

Sometimes, especially in longer projects, new inputs may be discovered that could require a modification of the project plan. If the plan is for a new product development, and the company discovers that a competitor is also planning a similar product, it may be prudent to consider how the project can be accelerated. This may require "crashing" the critical path to reduce the total elapsed time for the project.

If a project plan is modified, it often requires a reallocation of resources or a change in activity content. These changes must be effected throughout the project organization. It does not do any good just to change the project schedule; the actions that make it possible to change the schedule must be implemented.

The End Results Must Be Evaluated

One of the most difficult phases of project planning is to objectively evaluate the results after the completion of the project. It is important to determine what went right and what went wrong, thereby increasing the potential for making the next project more successful. In particular, variances in the amount of resources projected in the plan, versus the actual resources expended must be determined. For example, these techniques are widely accepted in the construction industry. Despite their use however, experience shows that construction projects often fail to achieve their defined objectives with respect to time and cost (Omar, 2009).

Implementation Approach

Developing project management (PM) capability within an organization will require a project management approach. A checklist of how to get started includes:

- Know and understand the strategic goals and objective of your organization so that your enterprise-wide approach to PM can be successful.
- Use a simple and proven approach to align the efforts of project teams.
- Work with a strategic training partner to ensure that people at every level of the organization learn the skills needed to use PM effectively to improve their value to the organization.
- Get big wins early by beginning with parts of the organization that have the least PM skills and the most to gain by using a simple PM approach.
- Measure the effectiveness of your project managers throughout the project by using a tool such as the PM Scorecard.
- Consider building a project management office (PMO) to serve as the centralized function of PM standards and best practices in your organization.
- Use a PM-competency assessment tool to assess where the most critical professional development and hiring needs are for your organization (LaBrosse, 2007).

Future

As businesses become more complex and their operations widespread, there will be a greater need for project planning. The concepts underlying project management are fairly intuitive. The difficulty is in applying these concepts in a committed and knowledgeable way. In that respect, the future is like the past. Organizations must keep working to do a better job of using project management.

In addition to the need for more project management, the risk of uncertainty in project scheduling (time and cost) is also increasing. It will become necessary for project managers to be able to adapt and modify as normal and assignable cause variations occur. Just as project management enables a company to become more agile, there is a need for project management techniques to become more agile as well.

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CHAPTER 5A

ADVANCED PLANNING AND SCHEDULING (APS)

NAME AND BRIEF DEFINITION

Advanced Planning and Scheduling (APS)—Techniques that deal with analysis and planning of logistics and manufacturing over the short, intermediate, and long-term time periods. APS describes any computer program that uses advanced mathematical algorithms or logic to perform optimization or simulation on finite capacity scheduling, sourcing, capital planning, resource planning, forecasting, demand management, and others. These techniques simultaneously consider a range of constraints and business rules to provide real-time planning and scheduling, decision support, available-to-promise, and capable-to-promise capabilities. APS often generates and evaluates multiple scenarios. Management then selects one scenario to use as the "official plan." The five main components of APS systems are demand planning, production planning, production scheduling, distribution planning, and transportation planning. Syn. Advanced Planning System. (Blackstone, 2013)

Advanced Planning & Scheduling (also referred to as **APS** and **Advanced Manufacturing**) refers to a manufacturing management process by which raw materials and production capacity are optimally allocated to meet demand. APS is especially well-suited to environments where simpler planning methods cannot adequately address complex trade-offs between competing priorities.

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Traditional planning and scheduling systems (such as Manufacturing resource planning) utilize a stepwise procedure to allocate material and production capacity. This approach is simple but cumbersome, and does not readily adapt to changes in demand, resource capacity or material availability. Materials and capacity are planned separately, and many systems do not consider limited material availability or capacity constraints. Thus, this approach often results in plans that cannot be executed. However, despite attempts to shift to the new system, attempts have not always been successful, which has called for the combination of management philosophy with manufacturing. Unlike previous systems, APS simultaneously plans and schedules production based on available materials, labor and plant capacity.

APS has commonly been applied where one or more of the following conditions are present:

- Make-To-Order (as distinct from make-to-stock) manufacturing
- Capital-intensive production processes, where plant capacity is constrained
- Products "competing" for plant capacity, where many different products are produced in each facility
- Products that require a large number of components or manufacturing tasks
- Production necessitates frequent schedule changes which cannot be predicted before the event

Advanced Planning & Scheduling software enables manufacturing scheduling and advanced scheduling optimization within these environments. (Lynch, 2009)

"APS is a 'best-of-breed' solution that exceeds the accuracy and detail of legacy systems or newer Enterprise Resource Planning (ERP) systems. Decision-support elements unique to an APS include: more finite capacity planning; real-time analysis and simulation; throughput optimization; and dynamically calculated lead times" (Dhanji, 1997).

Objectives (Reasons for Adopting Program)

The primary objective of APS is to take infinite-capacity schedules produced by the materials requirements planning (MRP) portion of the ERP system and transform them into finite-capacity schedules to be loaded back into the ERP system for execution. Consequently, it is imperative that the ERP system has current and accurate inventory levels, demand forecasts, scheduled due dates, and other information required by the APS system. It is also important that the ERP system be integrated to avoid multiple and conflicting sources of disparate information.

APS users are not looking for one fixed schedule. Because of the need for flexibility in scheduling, they are looking for several scenarios so they can evaluate the trade-offs between schedules and select a plan that will "deliver maximum benefit and minimum pain." (Parker, 1994)

Corporate downsizing and re-engineering, shorter product life cycles, predatory global competition, increased customer expectations, a focus on core competencies, the virtual enterprise—these are a handful of the factors forcing manufacturers of all types to a similar conclusion: Optimizing productivity within your own facility is no longer enough. The answer lies in working outside your immediate enterprise to develop an integrated and synchronized supply chain. This is an information-driven model that can modify business processes and cut through corporate cultures. At its core is advanced planning and scheduling (APS) (Alvord, 1999).

Distribution-intensive supply chains, such as those that supply consumer packaged goods, are more likely to buy APS solutions than are manufacturers with manufacturing-intensive or sourcing-intensive supply chains. This is a result of the market power shifting, in recent years, from the manufacturers to the retailers, such as Wal-Mart. As a result, manufacturers have to be able to satisfy retailer demand by reducing delivery response times, responding to promotions, delivering floor-ready merchandise and helping to lower inventory through such programs as quick response (QR), efficient consumer response (ECR) and vendor managed inventory (VMI). To be more responsive, manufacturers face shorter production runs, more changeovers, and increased difficulty in synchronizing production runs with a variety of packaging requirements (Aldred, 1998).

History (Time Line, Reasons Originated, Principal Developers)

One of the earliest references to an Advanced Planning System (APS) was in 1993 when Carp Systems International (CSI) and AT&T Istel announced an agreement that will integrate CSI's Advanced Planning System (APS) and AT&T's Istel's Provisa. The combination will allow users to pass plans between APS and Provisa to determine materials and capacity constraints, and then transfer the plans back to MRP II for execution. (Parker, 1994)

By 1999, companies producing ERP software were actively incorporating APS modules in their systems. They were emphasizing the point that

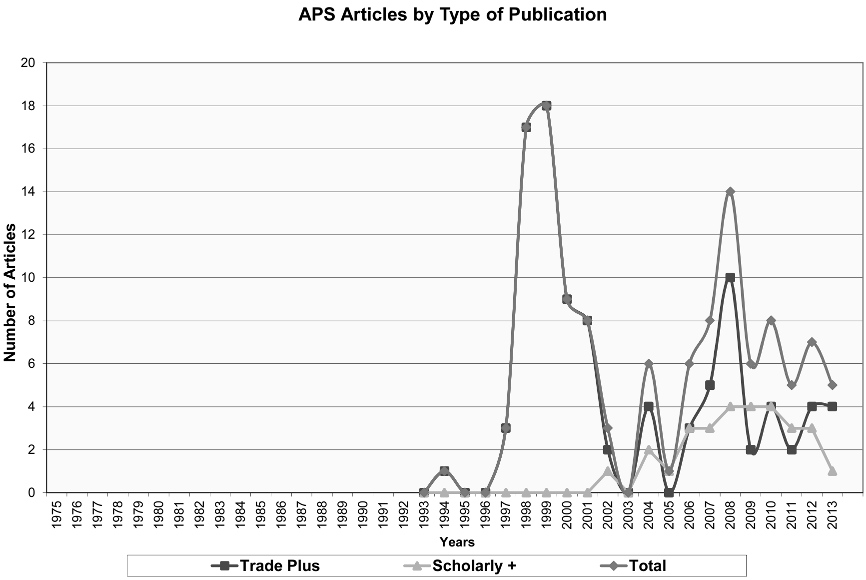

Figure 5A.1. Number of articles about Advanced Planning and Scheduling (APS).

having the two systems integrated provided the best results. Figure 5A.1 shows the number of articles written about APS. They quickly reach a peak just before the Y2K period, and then peak again in 2008, before settling down to what appears to be a gradual decline. Trade publications outnumber scholarly articles, as APS, along with the previously described programs of WMS and MES do not trigger a high level of interest among academics.

Expected Benefits (Tangible and Intangible)

Benefits of advanced planning and scheduling (APS) techniques include faster planning and replanning, increased stability of plans, reduced overtime, improved labor utilization, reduced changes in daily schedules, improved customer service levels, greater confidence in the plans, reduced inventory levels, increased plant throughput, and fewer changeovers because of better sequencing (Taunton & Feinbaum, 2006)

Another author lists these benefits:

- Greater planning and scheduling accuracy
- Improved customer delivery performance

- Better utilization of capital
- More effective use of resources
- Reduction of inventory
- Greater flexibility to meet new competitive challenges
- Capability to perform "what-if" simulations (Dhanji, 1997)

In addition to the benefits provided within a company, APS systems offer the potential to improve the effectiveness of supply chains. With complex mathematical algorithms crunching the variables, APS is making optimization of the supply chain a reality (Berger, 1999).

Barriers to Acceptance

APS systems were designed to supplement MRP systems. As a result, developers had to design interfaces between the APS and MRP systems. Early ERP systems didn't provide the capability of APS systems. Therefore, there was a need to interface APS with ERP. However, ERP systems were strongest in the financial and distribution areas, and weakest in the manufacturing area. Another barrier was in designing a compatible information technology between the ERP and APS software.

In speaking of the difficulty, one opinion is that a number of new software applications/products have been created to address the design limitations of ERP. These include:

- APS—Advanced Production Scheduling
- SCM—Supply Chain Management
- SFA—Sales Force Automation
- CRM—Customer Relationship Management
- MES—Manufacturing Execution System (Howells, 2000).

In the move toward lean manufacturing, many practitioners have felt the need to choose sides in the advanced planning and scheduling versus demand-flow manufacturing debate. In most cases, these two strategies can and should work effectively together. The real issue is the proper application of these tools, which must be determined within the context of each manufacturer (Gibson, 2001).

Despite advances in information technology (IT) and computer modeling techniques, humans still play critical roles in the production-planning processes—especially in a complex and dynamic manufacturing environment where incomplete, ambiguous, inconsistent and untimely data make automatic planning unrealistic. A rational human-computer collaboration scheme under an effective organizational structure would be in a better position to take advantage of the IT (Lin, Hwang, & Wang, 2007).

Implementation Approach

In order for an organization to benefit, however, a typical APS must be directly tied into an organization's enterprise resource planning (ERP) system since that is where all data resides. That connection is one reason why most major ERP vendors have joined the market by introducing APS-based modules. The other option is to choose an ASP vendor (of which there are many) whose offering can be integrated into an existing ERP system. (Barker, 2002)

A successful APS project is one in which business objectives are achieved; the company becomes self-sufficient in the use of the technologies, business processes and performance metrics; and implementation is achieved in a reasonable amount of time and at a cost that makes sense given the magnitude of the business benefits. Reasons for undertaking an APS project include replacing antiquated systems, standardizing best practices or achieving a specific business result (Naden, 2000).

Future

The first generation of APS systems was designed to overcome the limitations of MRP systems and other planning tools. As APS systems have improved, they are being used in more applications such as scenario building (Mann, 1999). In addition to their role in shop floor decision making, APS systems are expected to play a larger role in strategic decision-making.

MRP and MRPII used infinite capacity planning, an impractical assumption for shop floor scheduling. APS used finite capacity planning to provide a more realistic production plan. "Finite capacity scheduling is the ability to model the key capabilities and constraints of all the resources, processes, and materials: the material a processing unit can and cannot handle; the rate and quantities at which it can produce; how it handles replenishments; what a material's availability is; what labor is required" (Alvord, 1999).

A more recent research study explored how standardized advanced planning systems (APS) can be used for solving planning problems at tactical and strategic levels, and to identify the perceived effects of using APS. Findings show how APS support cost-optimized strategic network design and improved efficiency, capacity utilization and delivery service problems, using APS in global master planning processes. The cases show how APS can support cross-functional integration and supply chain commitment to a common plan (Jonsson, Kjellsdotter, & Rudberg, 2007).

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CHAPTER 5B

COMPUTER INTEGRATED MANUFACTURING (CIM)

NAME AND BRIEF DEFINITION

Computer-Integrated Manufacturing (CIM)—The integration of the total manufacturing organization through the use of computer systems and managerial philosophies that improve the organization's effectiveness; the application of a computer to bridge various computerized systems and connect them into a coherent, integrated whole. For example, budgets, CAD/CAM, process controls, group technology systems, MRP II, financial reporting systems, etc., are linked and interfaced. (Blackstone, 2013)

Another description of CIM was offered by a 1982 Autofact III Conference and reported in the Modern Materials Handling magazine:

"CIM entails computer use to link planning and scheduling with production and the control of materials' physical movement. The elements that make up CIM are: (1) computer-aided design/computer-aided manufacturing, that assists designers or manufacturers in creating and producing products; (2) group technology, grouping parts into families for design and manufacturing purposes; (3) "islands of automation,' automated machining centers; (4) flexible manufacturing, providing flow paths between machine tools or work centers; and (5) computer-aided process planning that provides or modifies the process plan and routing to convert a part into a manufactured product. The computer-integrated factory of the future will be composed of subsystems, controlled by inter-

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connected computers that form a distributed computer system. The ultimate goal of automation is total cost reduction with improved productivity." (Anonymous, 1982)

Objectives (Reasons for Adopting Program)

As the name implies, this program was designed to use computer technology to link manufacturing processes together to create a smooth flow of product from one operation to the next. Some examples of this linking included:

- Use computer-aided design (CAD) to design products and link CAD with computer-aided manufacturing (CAM) to provide programmed instructions to the individual production machines.
- Use computer numeric control (CNC) to operate the production and test equipment.
- Develop flexible manufacturing systems (FMS) to provide an automated materials handling system to move products from one machine to the next.
- Use programmed instructions, such as CNC, to make it possible to change over equipment from one product to another, providing flexibility to meet changing demands.
- Connect production planning and scheduling with machine processes to reduce response time and errors.

Snyder and Cox (1989) reported that "In computer-integrated manufacturing (CIM), various technologies are combined to produce an entire integrated factory. CIM usually includes such technologies as computer-aided design and manufacturing, robotics, automated material handling and identification, machine vision, and a communications network to link them."

By using computer control technology, it was expected that CIM would enable companies to reduce production costs and improve quality. Goldhar and Jilinek (1990) speculated that CIM would enable companies to make a wider variety of products available at reasonable prices. Others indicated that "The CIM database can be used by all departments, making it a holistic manufacturing/quality assurance data management system that can reduce scrap and labor input while improving machine usage and customer satisfaction." (Anonymous, *Quality*, 1984.)

Newer technologies, such as robots and machine vision, could be incorporated in CIM systems to add greater flexibility and efficiency to the manufacturing systems.

History (Time Line, Reasons Originated, Principal Developers)

CIM first came into prominence in the early 1980s. It was viewed as a major new management concept, not just a new technology. According to Attaran (1996) "CIM is a concept, not a technology. It is a management approach to using technology and techniques to integrate a business. CIM requires a new management perspective—perhaps even a new management philosophy."

CIM was actively written about during the 1980s and a number of companies, including Allen-Bradley, Continental Can Co. Inc., and Texas Instruments implemented CIM programs successfully (Teresko, Rohan & Welter, 1987). CIM became a reality because the computer and related technology made it possible. While computer technology was a driver, companies soon found that CIM technology alone would not produce sustainable results (Lei & Goldhar, 2002).

There was period of time, during the late 1980s and early 1990s, when CIM and MRP were competing to be the master integrating system of a company. This issue resolved itself by relegating CIM to the factory floor and MRP to the planning and control side. CIM used the computer to drive the production processes and MRP, and its successors, drove the information flow. Figure 5B.1 shows the number of articles written about CIM. After a flurry of activity during the late 1980s and early 1990s, the articles about CIM have declined, as other programs have taken its place.

Expected Benefits (Tangible and Intangible)

The primary benefit expected from CIM was increased productivity. Linking shop-floor machines to a network of computers and databases would provide control information to guide the manufacturing process. At the same time, managerial decision-making would be improved. (Ford, Ledbetter & Gaber, 1985).

Others expected greater flexibility and responsiveness, higher quality and improved resource utilization (Goldhar & Jelinek, 1990). There was also an expectation that CIM would integrate the factory floor with the administrative areas to create a more coordinated flow of information and consistent decision-making.

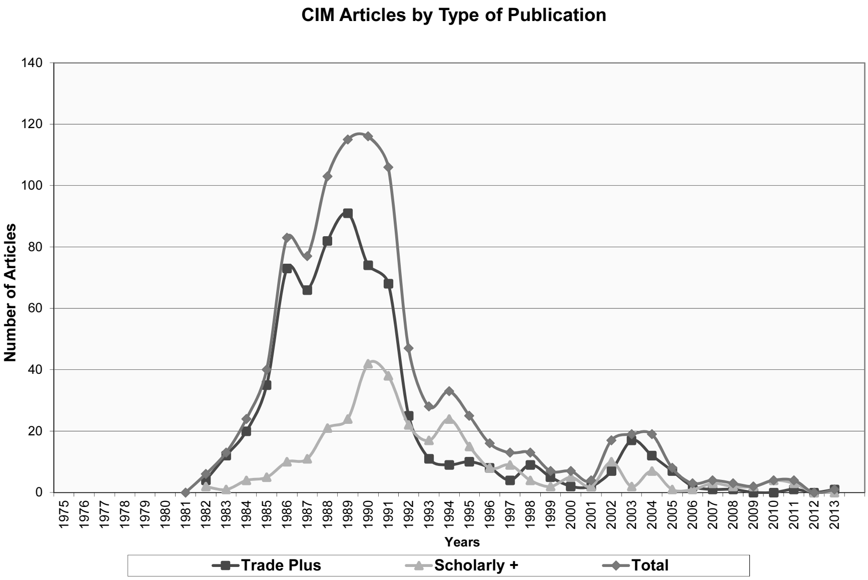

Figure 5B.1. Number of CIM articles.

An intangible benefit expected was that managers and employees would learn to use a new and powerful new technology. CIM was to be the next step toward the factory of the future (Teresko, 1983).

Kaplan (1986) observed that "While introducing CIM is costly, it offers a longer useful life, better quality, greater flexibility, reduced inventory and floor space, lower throughput times, and learning experience."

Barriers to Acceptance

Despite its wonderful promise, there were a number of factors that slowed the growth of CIM. The following are representative quotes:

In the early stages, much of the concern had to do with the technology itself. "The lack of standards in manufacturing languages has inhibited the growth of CIM." (Graiser, 1983). "Until manufacturers can freely exchange detailed product, manufacturing, and other information among a variety of systems, true computer-integrated manufacturing (CIM) will not become a reality." (Cotter & Skinner, 1985)

As time passed, there was a growing concern about the increasing scope of CIM, both actual and perceived. "Computer-integrated manufacturing (CIM) involves such a wide range of technologies and so vast a lexicon of terminology that a nontechnical manager can easily get lost in discussions of CIM concepts. CIM has not moved more rapidly toward full scale in U.S. companies because there is a lingering measure of befuddlement in the hierarchy of nontechnical management." (Sheridan, 1989)

Some companies found that the lack of top management support was a key obstacle. An Industry Week survey found that 40% of the respondents reported that one of the top obstacles to successful CIM implementation was that top management did not grasp the benefits. (Sheridan, 1989) Others reported that top management conceives of the system and then pushes it down onto a plant manager to implement (Teresko, Rohan, & Welter, 1987)

In 1990, Don H. Davis, Jr., President of Allen-Bradley, one of the pioneer companies in the use of CIM, posed the question "Is CIM really dead? In an Industry Week editorial, he then proceeded to identify five fundamental issues that had to be successfully confronted if CIM was to succeed. (1) The technology requires people who understand and support it, and make it work; (2) Top management must be committed to the philosophy of zero defects; (3) CIM should be put in the context of a well-defined business strategy, or vision; (4) The technology plan for CIM must include all elements of the company; and (5) It is important to select suppliers that have breadth and depth of support capability.

"Despite the potential of computer-integrated manufacturing (CIM) to improve quality and productivity while reducing costs, successful implementations are more the exception than the rule." (Attaran, 1996) He listed the following barriers to successful implementation—lack of management support, lack of effective organizational communications, inadequate strategic and business planning, rigid organizational structure, lack of IS (information systems) involvement, inadequate cost-justification methods, outdated cost accounting systems, and inappropriate selection of vendors.

Authorities warned that CIM required more than new technology. "New manufacturing technologies require new management skills such as a passion for detail and an integrative imagination. New managerial styles, organizational structures, changes in cost accounting, performance measurement procedures, human resource management, and capital budgeting are needed" (Hayes & Ramchandran, 1988). Almost 15 years later, other researchers reaffirmed this challenge. "Effective implementation of CIM technology to capture scope economies fully requires a foundation of manufacturing competence that is based on higher-order organizational learning and the creation of new forms of tacit knowledge that serve as the basis for faster firm-specific sources of innovation." (Lei & Goldhar, 2002)

The interest in CIM gave way to ERP as companies neared the Y2K issue at the end of the century, and the interest in CIM as a major program has not been revived as we enter the twenty-first century.

Implementation Approach

For a thorough explanation of the implementation process, see the book by Melnyk and Narasimhan (1992). They include a number of detailed case studies that illustrate the dos and don'ts of CIM implementation. They describe the "correct" CIM path as one of identifying focus, integration and simplification, and then automation as the final step in the process.

Melnyk and Narasimhan (1992) offer the following guiding principles for CIM implementation. For a more detailed list, see their book.

1. General Guiding Principles—Dealing with technology, people, organization, information and strategy.
2. Prerequisite Principles—All of the technology in the world cannot compensate for a system that is ill prepared for the changes required by CIM.
3. Operating Principles—Involve top management, minimize "fires," and integrate systems.
4. System principles—Involve all functions, deal with dynamic system.

Future

The future of CIM as a separate program is uncertain. Recent articles appear to focus primarily on the printing industry; otherwise, there is not much being written.

It is logical to assume that the basic concept of integrating manufacturing processes continues to be viable. However, it appears to be taking a back seat to the more active programs such as lean manufacturing and Six Sigma programs within a company and ERP systems with all of the add-ons, such as CRM, SRM, APS, MES and WMS.

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CHAPTER 5C

MANUFACTURING EXECUTION SYSTEMS (MES)

NAME AND BRIEF DEFINITION

Manufacturing Execution Systems (MES)—Programs and systems that participate in shop floor control, including programmed logic controllers and process control computers for direct and supervisory control of manufacturing equipment; process information systems that gather historical performance information, then generate reports; graphical displays; and alarms that inform operations personnel what is going on in the plant currently and a very short history into the past. Quality control information is also gathered and a laboratory information management system may be part of this configuration to tie process conditions to the quality data that are generated. Thereby, cause-and-effect relationships can be determined. The quality data at times affect the control parameters that are used to meet product specifications either dynamically or off line. (Blackstone, 2013)

An early definition envisioned Manufacturing Execution Systems (MES) as networked programs that hold instructions for entire operations and gather process data over hours or days. MESs also track products from the raw-material stage through manufacturing and provide documentation for every lot made. An MES has 3 main parts: (1) a large database or set of databases; (2) application programs; and (3) operator interfaces. Perhaps the MES's most important capability is data capture and analysis (Chemical Engineering, 1993).

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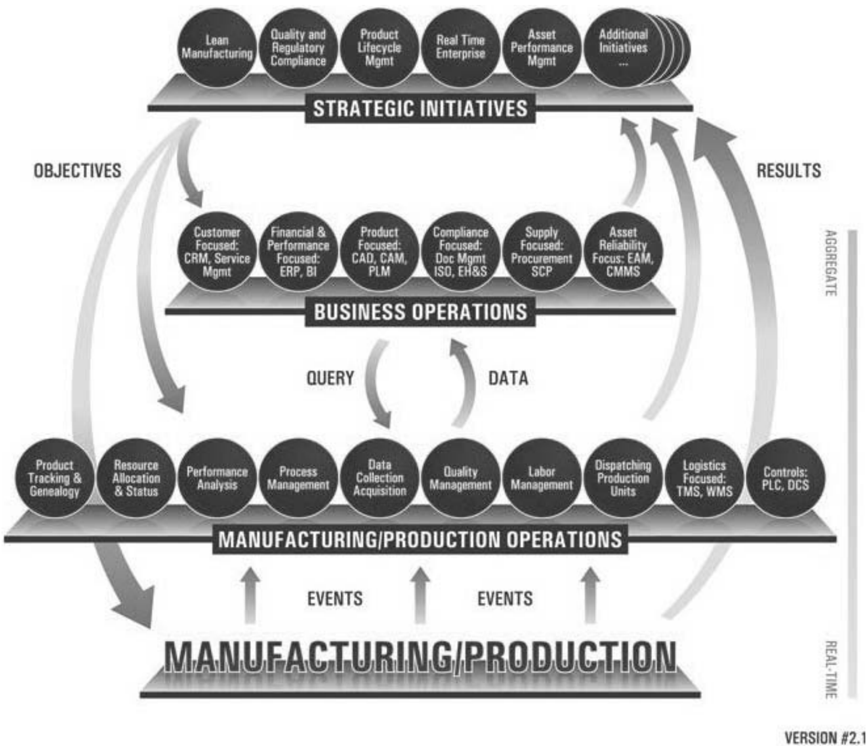

Note: Used with permission.

Figure 5C.1. MES functional model (2013).

There are variations in the definition of a MES. The Manufacturing Execution System Association (MESA) International shows the system components and how it interacts with external systems in Figure 5C.1.

A MES has to satisfy three requirements:

- Information interfacing with three systems: ERP, operational systems, and other MESs.
- Responsiveness: an MES has to respond to inquiries from ERP, some of which may come from suppliers or customers
- Proactiveness: an MES has to proactively send alarm messages beyond the control of the MES—machine breakdowns—or other event messages—start orders or complete orders. (Huang, 2002)

Objectives (Reasons for Adopting Program)

The primary objective of MESs is to provide a link between the ERP system and the shop floor operations. Plans come to the MES from the ERP system and the MES transforms the production plans into viable schedules, and then tracks the progress of the work orders through the plant. It collects data about production, hours, and quality and reports this back to the ERP system for further analysis. "MES core functionality centers on tracking work-in-process through detailed product routing and tracking, labor reporting, resource and rework management, production measurement, and data collection. By capturing information about set-ups, run times, throughput, and yield, managers are able to measure constraints, identify bottlenecks, and get a better understanding of manufacturing capacity. At the same time, an MES often is the means to convey production plans and schedules to the plant floor" (Fulcher, 2000).

Manufacturers both in the United States and abroad are in a race to respond faster to customers while reducing costs and improving quality. To compete successfully, the manufacturer must know exactly what is happening in the plant and be able to act on it. The closer the information is to real-time, the better the manufacturer's ability to compete and respond. Among the software tools to help manufacturers with this real-time challenge are powerful planning packages, including MRP, MRP II, and the newly emerging COMMS. While quite effective in capturing history, inventory, material needs, and other static information, these systems do not provide the kind of dynamic and interactive feedback or proactive approach that today's competitive environment demands. Enter manufacturing execution systems (MES). As the name suggests, this high-level software is able to track and manage all aspects of the job while it is in the execution phase or in process (Hakanson, 1994).

History (Time Line, Reasons Originated, Principal Developers)

MES were introduced in the early 1990s. MRP and MRP II were effective in planning static production schedules but were not effective in collecting information about actual operations. The MES was designed to collect data about what is happening on the shop floor at any point in the production cycle. This data is available real time, allowing adjustments to be made to a job while it is running and preventing problems that may not otherwise be discovered or discovered too late (Hokanson, 1994).

Hokanson (1994) reports that "MES technology has evolved in response to customer demand. The resulting product is now referred to as integrated MES. It includes tools like resource management, capacity scheduling, maintenance management, product distribution, statistical quality control, laboratory information management, process management, data collection, plant-wide document management and process optimization. An MES is driven by the product generation, rather than by the manufacturer's planning needs or customer demands." While AMR is the group that coined the term "MES," the Gartner Group has a similar product they call manufacturing operations management systems (MOMS). A group of MES vendors joined to form MES International to help promote the concept and to begin to develop standards, thereby limiting confusion (Hokanson, 1994)

While MESs were originally designed to manage work orders and workstation assignments, it has evolved into the indispensable link between the production and logistics processes and those that use the information generated within the MES. (McClellan, 2004a)

Figure 5C.2 shows the number of articles published about MES. Beginning in the early 1990s, the number has increased and appears to still be a popular topic, at least among trade publications. The small number of scholarly articles indicate this program has not yet become a popular research topic.

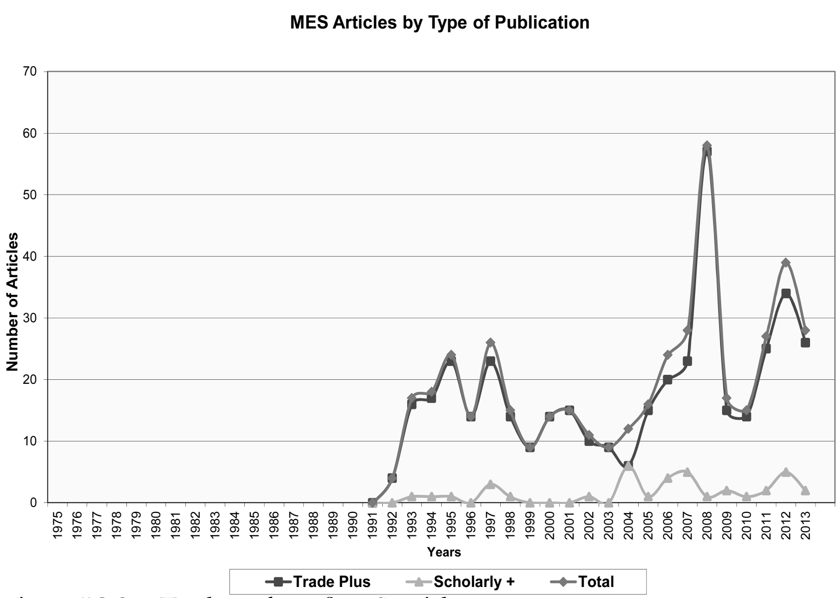

Figure 5C.2. Total number of MES articles.

Expected Benefits (Tangible and Intangible)

Some of the benefits attributed to MES include reduction in the time-to-market, improved productivity, enhanced quality and lower costs. For those manufacturers in regulated industries, a MES can produce the necessary tracking data and reports (Hokanson, 1994).

A major role of the MES is to collect data and deliver it to the planning systems, such as ERP. The Planning systems include Materials Requirements Planning (MRP), Manufacturing Resource Planning (MRP II), and Enterprise Resource Planning (ERP). Most of these operated in a batch mode, although some ERP systems can now support on line responses.

The Execution-Level Systems include, in addition to MES, Warehouse Management Systems (WMS) and Quality Assurance Systems. Most of them were designed to provide on line feedback. Device Control systems include Programmable Logic Controllers (PLC), Systems Control and Data Acquisition Systems (SCADA), and Process Control Computer Systems. They operate in milliseconds, controlling processes and machine movements in real time. (McClellan 2004b). McClennan (2004a) believes that MES become an integral part of a Product Life-Cycle Management system (PLM) by providing data that can lead to product and process improvements.

Barriers to Acceptance

As with many of the software packages, there is an initial cost for installing the software, especially in integrating the MES with the ERP system. In recent years, there has been a movement toward consolidation of MES software vendors; this can cause some compatibility and ongoing support problems.

The emergence of the supply chain means that MES vendors must consider how to present their products in a world of networks and company relationships. Paul Mann (2000) explains it. "Put all the pieces together and you get what ProfitKey now calls an enterprise manufacturing execution system that includes an APS (Advanced Planning and Scheduling System) and DSS (Decision Support System), a much broader definition than the MESs that dominated this market for years."

While the technology has existed for a couple of decades, changing corporate cultures remains one of the most resistant barriers. As one executive puts it, "But today, there really aren't any technological barriers to prevent this from happening. The only barriers are cultural—those who say they're not going to change because they've done business another way for years" (Mann, 2000).

A researcher in the pharmaceutical industry reports that MESs have been used by pharmaceutical companies for several years and have provided an important interface between enterprise resource planning (ERP) systems and plant-floor control or distributed control systems (DCS). But they're also not without their challenges. The time required to implement and configure an MES, the cost of initially validating the system and revalidating each time there is a change, and the combined time and cost of staying current with FDA regulations all weigh heavily when considering MES as an option. Though the benefits can be great, management should also evaluate the difficulties they could face as a result of integrating such a system (Russell, 2004).

Implementation Approach

One of the main challenges of MES implementation is the time it takes to integrate it into a company's existing automated systems. Other barriers include the lack of standardization in the industry, and the need to configure and customize the system to the individual company doing the implementation (Russell, 2004).

Implementations can be done in two ways. The first is to install the complete system at one time. This is a major project and takes months, even years. The second is to install one module at a time, which may enable a company to get some benefits sooner but invite incompatibility problems with the legacy systems.

Future

How will MES fare in the world of lean manufacturing and increased variety of products? It will do well, according to some. "Simply stated, the greater your product variety and process complexity, the greater the benefit of the MES. An MES is also the perfect complement to lean. Because it is process oriented, not accounting-based, the system can manage various levels of scheduling and order management across the business (Scultz, 2006).

Companies could cut their production expenses and time by tying the manufacturing floor to the product lifecycle management (PLM) system. To get the true value from such a link, companies need to look at tying PLM to their manufacturing execution systems so information can easily move back and forth from engineering to manufacturing. The manufacturing execution system (MES) tracks and manages the way jobs move across the factory floor. The trouble is, only a few software vendors now offer off-the-shelf applications that marry lifecycle management and manufacturing execution functions. Though the day of easy integration has yet to arrive, many companies are using PLM to reduce cycle time. Tying PLM to research and development and to departments further downstream can also help companies design products to suit particular consumer needs (Thilmany, 2007).

In looking ahead to the electronic age of manufacturing, researchers expect even greater dependence on MES systems. Intelligent Manufacturing Systems requires advanced and efficient manufacturing technologies, management and procedures in order to achieve value creation in global markets. E-Manufacturing is the set of information technologies that allows companies to achieve on demand manufacturing through the integration of e-business applications. Cornerstone of this concept are Demand Flow Technology, Manufacturing Execution Systems (MES) and Digital Operational Method Sheets (OMS) which are vital to control shop floor operations where there is a need to balance manual and automated operations (Sanatella & Molina, 2006).

As supply chains become more complex and globally dispersed, some believe that a single MES is not enough and it is necessary to develop distributed MESs to integrate the distributed operations (Huang, 2002).

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CHAPTER 5D

THEORY OF CONSTRAINTS (TOC)

NAME AND BRIEF DEFINITION

Theory of Constraints (TOC)—A management philosophy developed by Dr. Eliyahu M. Goldratt that can be viewed as three separate abut interrelated areas—logistics, performance measurement, and logical thinking. Logistics includes drum-buffer-rope scheduling, buffer management, and VAT analysis. Performance measurement includes throughput, inventory and operating expense, and the five focusing steps described later in the Implementation section. Thinking process tools are important in identifying the root problem (current reality tree), identifying and expanding win-win solutions (evaporating cloud and future reality tree), and developing implementation plans (prerequisite tree and transition tree). Syn: constraint theory. See: constraints management (Blackstone, 2013).

The components of TOC can be understood by some of the vocabulary associated with it.

- A **Constraint** is any element of factor that prevents a system from achieving a higher level of performance with respect to its goal. Constraints can be physical, such as a machine center or lack of material, but they can also be managerial, such as a policy or procedure (Blackstone, 2013).
- The **Drum-Buffer-Rope (DBR)** scheduling technique is one of the original principles of TOC. DBR lets the constraint act as the pacesetter for the rest of the operation. The constraint is therefore the

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"drum," keeping pace. The "rope" is what ties market demand to the first production step; it's what schedules the release of materials into the system. And the "buffer" is a protective window of time ensuring that the drum never runs dry.

- **Current Reality Trees** (CRT) A logic-based tool for use cause-and-effect relationships to determine root problems that cause the observed undesirable effects of the system (Blackstone, 2013). They are tools that help to identify a root problem.
- **Future Reality Trees** (FRT) A logic-based tool for constructing and testing potential solutions before implementation. The objectives are to (1) develop, expand, and complete the solution; and (2) identify and solve or prevent new problems created by implementing the solution. (Blackstone, 2013) These diagrams help to identify the most effective and feasible solutions to problems discovered in the CRT.
- The **Evaporating Cloud** is a tool designed to understand assumptions related to a conflict, constraint, or problem in general. Once the assumptions are identified, they can be negated. At that point, the problem is easier to solve. (Blackstone, 2013)
- **Theory of Constraints Accounting** (TOCA) is a method of internal measurement and reporting tailored to support a TOC environment. TOCA accumulates costs and revenues into throughput, inventory, and operating expenses and does not create incentives to build inventory. TOCA is similar to the cash flow concept of accounting (Blackstone, 2013).

These tools and concepts share a common facet: they are all based in logical reasoning. Causes are traced from undesirable effects, and through the alteration or elimination of those causes, solutions are derived.

Objectives (Reasons for Adopting Program)

The theory of constraints (TOC) is a method for improving a system by identifying a constraint which stands in the way of an organization and its goals. In business, the primary goal is usually the maximization of profit. TOC aims to direct a company in achieving this goal by improving throughput—defined in TOC as the rate at which an organization generates money through sales—while maintaining steady operating expenses. Also, since constraints and conflicts can be found in other places than the shop floor, TOC entails a variety of problem-solving methods applicable to strategic management.

One of the main ideas of TOC is to increase profit without changing operating costs. In some cases, a capital investment may be necessary to break a constraint, but each operation and each constraint are distinctly different. Eli Goldratt's works continue to be the primary sources for TOC methodology. Notable books include:

- *The Goal: A Process of Ongoing Improvement*. (with Jeff Cox), North River Press, 1992.
- *It's Not Luck*. North River Press, 1994.
- *Critical Chain*. North River Press, 1997.
- *Necessary but Not Sufficient*. (with Eli Schragenheim and Carol Ptak), North River Press, 2000.

History (Time Line, Reasons Originated, Principal Developers)

In the late 1970s, physicist Eliyahu (Eli) Goldratt developed commercial software called Optimized Technology Production through his company Creative Output; this is where the earliest roots of TOC can be found. Goldratt's production scheduling software was received with indifference by the business community, but rather than abandon the idea, Goldratt did something unusual. He wrote a book—technically, it's more like a novel. In *The Goal* (with Jeff Cox, North River Press), plant manager Alex Rogo saves the plant, his job, and his marriage by applying the principles of TOC to his work and life. Publishers didn't expect the world's first manufacturing novel to be a success, but it was, and it sparked a new trend in management that has been credited with having an impact comparable to JIT and TQM (Goldratt & Cox, 1992).

Like many management philosophies, TOC was first used to improve manufacturing departments. The ideas were especially valuable for unpaced, flow lines where line balancing didn't work. In a short time, TOC also found a place in several administrative functions. Finance, distribution, quoting, marketing, sales, human resources, and corporate strategy departments have all benefited from the logical problem-solving techniques employed in TOC. Industries other than manufacturing—namely, the service sector—have also adopted TOC methods in their operations and administration.

Figure 5D.1 shows the number of articles published about TOC. Articles first appeared about 1990 and have shown some increase, almost entirely in scholarly journals. In contrast to other programs in this sec-

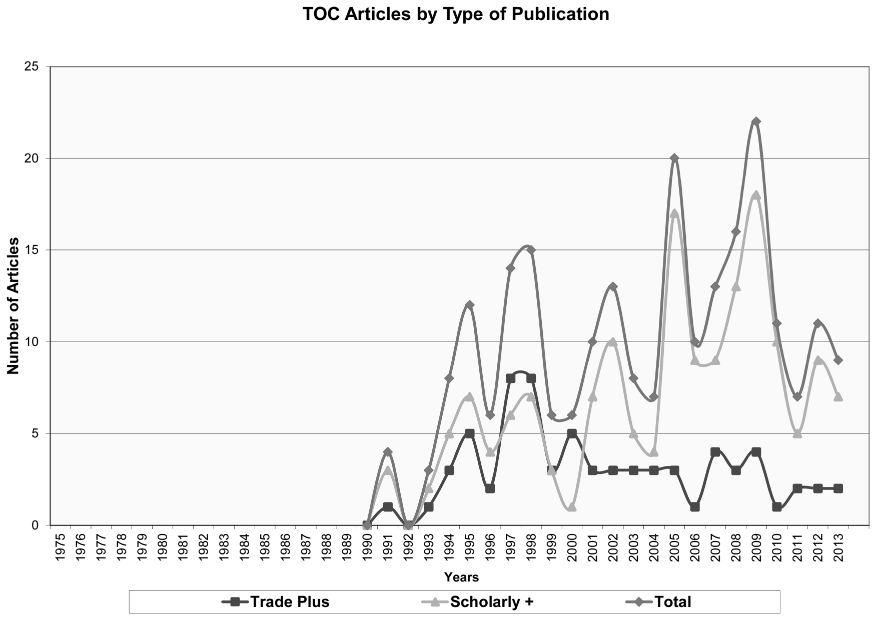

Figure 5D.1. Total number of TOC articles.

tion—APS, MES and WMS—researchers have found TOC to be a rich area for study.

Expected Benefits (Tangible and Intangible)

In practice, TOC methods like drum-buffer-rope scheduling have yielded improvements in throughput, quality, on-time delivery, and customer satisfaction in general. As TOC evolved through Goldratt's books, other tools like CRTs, FRTs, and Evaporating Clouds have been introduced to address strategic management problems as well. Applying TOC is viewed by some as an easier, more successful, and less risky implementation than initiatives like total quality management (TQM), just-in-time (JIT), or business process reengineering (BPR), because TOC focuses on one problem link at a time, rather than try to improve all links at once (Gardiner, Blackstone & Gardiner, 1994).

Barriers to Acceptance

Application of TOC may require that areas of operation without a bottleneck work at a pace slower than before. This will increase idle time, and management may have to think of creative ways that this time can be utilized. This problem stems from the assumption that efficiency cannot be achieved unless employees are working at all times. Goldratt disagrees with this assumption, saying that small periods of idle time are better than large WIP inventories brought on by bottlenecks. Another possible problem from TOC implementation is that traditional cost accounting measures may reflect an increase in the cost of goods sold even though actual cash outlay for labor or parts has not increased. This could be because of additional setups required by smaller batches. A theory of constraints accounting system (TOCA) would address this by more concretely accumulating costs into throughput, inventory, and operating expenses (Dugdale & Jones, 1997).

Implementation Approach

Implementing the theory of constraints in business generally involves the **five focusing steps**. The objective of these steps is to identify a system constraint, determine how to exploit the constraint, and ultimately maximize profits through this exploitation.

1. Identify the constraint in a system. Typically, this is going to be machine hours or skilled labor hours for a particular machine or phase of the process. The constraint is going to be the area that consistently has a backlog of WIP in front of it.
2. Determine how to exploit the constraint to improve the system. Exploiting the constraint involves using available resources to keep all processes constantly running, including those found after the bottleneck. One solution may be to shift labor from other processes to the constraining area.
3. Subordinate all parts of the system to support Step 2. An example of this would be to encourage all work areas to complete only the amount of material that can be handled at any given time by the constraining process. In other words, processing would be done at the constraint's pace.
4. Elevate the constraint. Use the new operations developed in the previous steps to make a higher profit level possible. Implementing smaller batch sizes is one way to do this.
5. If any of the previous steps has broken the original constraint or led to identifying a new one, begin again with Step 1. This step is where continuous improvement is included in the theory of constraints (Gardiner, Blackstone & Gardiner, 1994)

Virginia Semiconductor Inc. (VSI) is a famous example of the theory of constraints in successful implementation. VSI is a manufacturer of custom silicon products for the microelectronics industry. The organizational chain consisted of five links: marketing and sales, growing, sawing, lapping, and polishing. Polishing was identified as the constraining link, and it was exploited by shifting manpower from other functions and controlling the amount of material that flowed through the factory until the entire operation worked at the same pace as polishing. Within four months, VSI saw a 4.5% increase in process yield, a 26% increase in on-time delivery (to 96%), a decrease in manufacturing cycle time of 82%, and a 90% drop in WIP inventory (Miller, 2000).

Another case involved the combined use of TOC with lean and Six Sigma processes. As the author explains: This approach was called integrated TOC and lean Six Sigma (iTLS). The iTLS model consisted of three stages. First, the iTLS model applies TOC to bring focus and a systematic view to the problem at hand. The second stage uses lean tools to identify the true value in the processes' value stream and highlights the non-value-added activities. Third, iTLS applies Six Sigma tools and techniques in order to control the process stability, sustainability and level of required perfection. The authors divide these three phases into seven steps, as follows:

- Step 1—Mobilize and focus (TOC)
- Step 2—Exploit the constraint (TOC and Lean)
- Step 3—Eliminate sources of waste (Lean and Six Sigma)
- Step 4—Control process variability (Six Sigma)
- Step 5—Subordinate feeder activities—Six Sigma and Lean
- Step 6—Remove constraints and stabilize—Lean and TOC
- Step 7—Re-evaluate system (TOC) (Pirasteh & Kannappnan 2013)

Future

In addition to standalone applications of TOC, several researchers have found that TOC can be used in conjunction with other programs. Gupta (2012) found that TOC and the Balanced Scorecard (BSC) approach work well together to improve profitability and resource utilization. Creasy (2013) studied the use of TOC with Six Sigma in a small hospital and found that the wait time for patients in the preadmission process was reduced dramatically.

Every organization has at least one constraint—if they didn't, companies would have infinite capacity and sales. A constraint shared by all organizations is time. Managers usually have an intuitive sense for which phase of an operation is the most pressed for time; TOC provides logical steps for addressing and exploiting this constraint while extinguishing assumptions that hindered performance in the past.

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CHAPTER 5E

WAREHOUSE MANAGEMENT SYSTEMS (WMS)

NAME AND BRIEF DEFINITION

Warehouse Management System (WMS)—A computer application system designed to manage and optimize workflows and the storage of goods within a warehouse. These systems often interface with automated data capture and enterprise resources planning systems (Blackstone, 2013).

A computer-based system that provides information to manage the warehouse operations and communications links with customers and suppliers. The primary purpose of a WMS is to control the movement and storage of materials within an operation. Directed picking, directed replenishment, and directed putaway are the key to WMS. The detailed setup and processing within a WMS can vary significantly from one software vendor to another; however, the basic logic will use a combination of item, location, quantity, unit of measure, and order information to determine where to stock, where to pick, and in what sequence to perform these operations. Initially a system to control movement and storage of materials within a warehouse, the role of WMS is expanding to include light manufacturing, transportation management, order management, and complete accounting systems (Piasecki@inventoryops.com).

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Objectives (Reasons for Adopting Program)

The primary purpose of a WMS is to control the movement and storage of materials within a warehouse. The objective of a warehouse management system is to provide a set of computerised procedures to handle the receipt of stock and returns into a warehouse facility, model and manage the logical representation of the physical storage facilities, manage the stock within the facility and enable a seamless link to order processing and logistics management in order to pick, pack and ship product out of the facility. Warehouse management systems can be stand alone systems, or modules of an ERP system or supply chain execution suite (Wikipedia, 2010).

Infor SCM's Warehouse Management system solution enables companies to see what inventory is or will be available, organize work and align resources and labor to satisfy customer requirements, and optimize fulfillment and distribution processes to ensure that products are delivered on time and in full, each and every time. The result: improved supply chain management with end-to-end fulfillment from order inception to delivery.

Warehouse Management is a proven, advanced WMS software solution for manufacturing, distribution, and retail enterprises and third-party logistics providers (3PLs) that can be used by enterprising organizations of all sizes. It helps companies maximize product placement strategies, prioritize tasks, implement fair productivity standards, and increase logistics efficiency. Capabilities include:

- *Inventory Management*—multiple units of measure, lot control, and catch weights improve inventory accuracy and visibility to offset margin squeeze.
- *Work and Task Management*—deep functionality for work order/location grouping into batches and waves optimizes productivity.
- *Labor Management*—forecasting, time and attendance, assignment scheduling and monitoring, and enforcement of standards optimize labor and reduce costs.
- *Cross-Docking*—flow-thru, trans-shipment, and opportunistic process capabilities increase inventory speed and throughput.
- *Slotting and Optimization*—the ability to arrange SKUs advantageously within a range of pick faces/slots accommodates variable demand.
- *Value-Added Services*—deferred manufacturing, preparation of store-ready pallets, light assembly, and kitting enable customization of products closer to the point of sale.

- *Yard Management*—coordination of yard movement with receiving and order fulfillment improves visibility, productivity, and security.
- *Multiple Inventory Ownership, Billing, and Invoicing*—the ability to track multiple inventories, employ multiple business rules, and manage billing for multiple customers improves 3PL and distributor efficiency.
- *Voice-Directed Distribution*—voice-enabling order selection, replenishments, put-aways, transfers, and receiving enhances productivity and accuracy. (Infor 2009 http://www.infor.com/solutions/scm/wms/)

History (Time Line, Reasons Originated, Principal Developers)

Figure 5E.1 shows the number of articles published about Warehouse Management Systems (WMS). Trade articles completely dominate those in scholarly publications. The first articles appeared in the early 1990s, increased rapidly during the 1990s, and have remained level during the last decade.

Figure 5E.1. Total number of WMS articles.

Expected Benefits (Tangible and Intangible)

Warehouse management systems (WMS) offer manufacturers a number of compelling benefits, including better inventory accuracy, increased facility throughput and worker productivity, and improved customer compliance. (Cable, 2009)

Warehouse management systems (WMS) are critical to the survival of today's warehouse business. These systems use the latest in computer software and hardware to optimize the work of people, the handling of inventory, and the flow of information within the warehouse. It can extend these efficiencies outside the four walls of the warehouse throughout the entire distribution chain. Implementing WMS today can give a warehouse the keen competitive edge it needs to survive in the future. (Trunk, 1997)

Some of the benefits include reduced inventory, increased labor productivity, improved shipping accuracy, increased inventory accuracy, increased perfect order rates, reduced direct operating costs and increased overall revenue (Infor, 2009)

Barriers to Acceptance

Warehouse management systems (WMS) are becoming a core requirement in today's highly competitive supply chain strategies. Return on investment (ROI) is a business driver and bottom-line decision criterion for many organizations; therefore, it is critical for the investment component to be as accurate as possible to provide a meaningful ROI result. However, all too often, system justifications are based solely on the software and hardware purchase prices as the investment cost component. There are several other cost drivers that can increase the overall investment required to implement a system successfully. Core elements of WMS include: software and hardware, system integrator, software vendor assistance, host system modifications, and internal corporate costs. (Barnes, 1999)

Because of the ever-increasing demands placed on warehouses, many companies are implementing or upgrading a warehouse management system (WMS). WMS implementation projects can take anywhere from three months to three years, depending on system complexity, the number of installation sites, and the project team's level of experience and commitment. People issues can also be a barrier to successful implementations; therefore, a project manager's goal is to assemble a team capable of maintaining motivation and commitment throughout the duration of the project. It is important to develop a team organizational chart based on functional responsibilities. Next to having a system that works, a well-trained user group is the essential component to a successful implementation (Cooper, 1999).

Implementation Approach

Even before beginning the implementation, it is important to select the right WMS software system. Steps to be considered include:

- Establish the vendor pre-qualification criteria by defining which "mission critical" elements could include: WMS features and functionality; vendor history and installation; vendor project management and staffing; vendor training and documentation; and vendor system interfacing.
- Vendors visit the warehouse. Such visits will allow the vendors to obtain more information about the warehouse operations and enable them to present the best possible bid. The vendor should be prepared to provide a brief overview of the respective company and system. The total process should be limited to three hours, to allow for two vendor visits a day. Because this is an analytical process, functional requirements must be analyzed and reviewed—this crucial decision must not be made based on sales presentations.
- Evaluate bids and select vendor. Based on the evaluation criteria, evaluate vendor proposals and make vendor recommendations. The consulting firm should utilize the weighted criteria to complete the process. These areas should include: receiving; putaway; storage; returns; quotation completeness; implementation and schedule; training and documentation; related experience; company strength; support capabilities; and system cost (Benefield, 1998).

A major practical question is then whether a given warehouse should implement a standard or a tailor-made WMS. A standard WMS simplifies the implementation but requires making compromises between the way a warehouse wants to work and the way the system allows the warehouse to work. In certain environments, such compromises might seriously degrade warehouse performance (Faber 2002).

As WMS technology has matured over the years, today's definition of WMS goes far beyond receiving, picking, shipping and cycle counting. Manufacturers now expect sophisticated labor management, pick-face slotting, yard management and features like parcel manifesting. Those are now all in the broader category of warehouse management. Considering the broad range of warehouse environments, and the range of features and capabilities now being offered by WMS software, selecting the right WMS can be challenging. Cable (2009) suggests companies consider these factors when making their decision:

- Vendor Stability. Consider a company's financial stability and also the likelihood of their being acquired.
- Integration. Be sure the WMS system is compatible with the existing ERP and other relevant systems within the company.
- Configurability. Can the system be customized; if so, will that reduce its access to system upgrades in the future?
- Right-sizing. How many "bells and whistles" are included in the software that may not be used by the buyer? (Cable 2009).

Regardless of how perfect a fit the WMS system may be, people problems can hinder any project; therefore, special attention should be given to methods for managing these issues.

Future

With fluctuations in cost and consumer demand, warehousing must be able to keep up with changes to remain competitive. Flexibility means being easily adaptable to change. Consumer demand is a major reason why a warehouse must remain flexible, because a consumer's needs are constantly changing. Changes in consumer psychology will impact the warehouse of tomorrow. Flexibility must be designed into every function of the warehouse: receiving, material handling, storage, picking and sortation, shipping, labeling and packaging, the warehouse management system and personnel. Without complete flexibility, the warehouse risks losing its competitive edge (Brockman, 1997).

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CHAPTER 6A

JUST-IN-TIME (JIT)

NAME AND BRIEF DEFINITION

Just-in-Time (JIT)—A philosophy of manufacturing based on planned elimination of all waste and on continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery, and includes all stages of conversion from raw material onward. The primary elements of Just-in-time are to have only the required inventory when needed; to improve quality to zero defects; to reduce lead times by reducing setup times, queue lengths, and lot sizes; to incrementally revise the operations themselves; and to accomplish these activities at minimum cost. In the broad sense, it applies to all forms of manufacturing—job shop, process, and repetitive—and to many service industries as well. Syn: short-cycle manufacturing, stockless production, zero inventories. (Blackstone, 2013)

JIT has permeated more industries and cultures than perhaps any other recent management trend. The earliest developers and adopters of the program were large Japanese institutions in the automotive manufacturing industry, but JIT philosophy and principles have also been applied in Western cultures, small businesses, and service industries like transportation, healthcare, and banking. In manufacturing, JIT success is usually associated with a business that has a significant amount of repetitive business. A continuous flow operation would be ideal for JIT, but not exclusively so.

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Objectives (Reasons for Adopting Program)

Broadly, JIT aims to accomplish any goal that a business might have; its practices can positively affect each financial statement as well as less tangible measures like employee morale and customer satisfaction. Below are some of the reasons that companies have adopted JIT:

- To reduce overall inventory—buffer stock, work-in-progress, and finished goods.
- To increase cash flow.
- To make quality control more pervasive and efficient.
- To increase productivity.
- To achieve better flexibility and delivery responsiveness.
- To reduce setup times.
- To utilize more plant space for revenue generating operations.
- To motivate employees.

Obviously, JIT can cover a lot of bases. Some companies, especially smaller ones, did not adopt the entire JIT philosophy, but saw positive results from just a few techniques.(Schoenberger, 1982)

JIT is most often characterized by a dramatic decrease in overall inventory. Each level of inventory, beginning with raw materials, ideally arrives at the appropriate production step as needed—not before and not after. Moving quickly from batch flow to continuous flow is not a smooth transition, however. Initially, multiple problems occur, but the managers of some new JIT programs may be happy to see these problems because they will be the company's first targets for improvement. Since they arise after the security blanket of safety stock is removed, the problems are thought to be deficiencies that were previously unnoticed or accepted as inevitable. Other companies already know where the problems exist and choose to reduce inventory slowly to avoid the hazards of line interruptions and shipment delays. Some areas will have a backlog of parts while others are starved, and by creatively examining where and why the problems occurred, a team of employees can begin to devise innovative solutions and thus, more efficient ways to produce goods. Much like Total Quality Management (TQM), an infinite cycle of these solutions, over time (*kaizen),* becomes a vital part of the company culture. Low inventories, problem solving, and *kaizen* philosophy are readily associated with JIT, as they should be, but it is also very important that they are thought of as three stages, each building on the last (Schoenberger, 1982).

History (Time Line, Reasons Originated, Principal Developers)

The first practitioner of large-scale JIT was none other than Henry Ford, although he didn't call it such. Synonymous with mass production, Ford Motor Company's River Rouge facility had a production cycle of only four days in 1921. This included time spent processing ore in a steel mill built on site. (Schoenberger, 1986) Ford's success was widely acknowledged and imitated, but short lead times and thin inventories were often bypassed with the advent of F. W. Harris's economic order quantity (EOQ).

After WWII, stockless production was abandoned in the United.States. Across the Pacific, however, Kiichiro Toyoda, Taiichi Ohno, and Shigeo Shingo were applying inventory reduction principles to his Toyota Motor Company in the form of Kanbans—signals to send material from one processing stage to another. Toyota experienced dramatic success as a result of Kanbans, as did other Japanese companies who emulated the idea. Kanbans eventually evolved into a company-wide philosophy centered on the continuous discovery and elimination of cost-added processes and activities. This practice translates into one Japanese word: *kaizen.* Kaizen, when applied to an entire company—process flows, information systems, and each employee from entry-level to executive management—comprised what Americans later knew as JIT (Hall, 1983).

The first documented article on JIT in the United States appeared in 1977; it described the principles and contended that the program would not work in Western cultures (Vokurka & Davis, 1996). However, by the early 1980s, JIT was getting more favorable attention in the States as companies were searching for ways to compete against the Japanese. Some of the first prominent adopters were Goodyear, Harley-Davidson, and General Electric. From 1980 to 2002, the U.S. economy tripled while inventories only doubled, suggesting widespread acceptance of JIT.

The philosophy continues to evolve, evidenced by the relatively new JIT II, which is characterized by supplier representatives who work full-time at the company's site, overseeing reordering and other logistic issues. In recent years, as a result of unexpected disruptions in the supply chain, such as earthquakes, political uprisings in emerging countries, and other unexpected events, many companies are reevaluating their strategic safety stocks to try to balance the benefits of lower inventories with the costs of stockouts.

Figure 6A.1 shows the number of articles written about JIT. Although earlier writings used such terms as the Toyota Production System, stockless production, and world-class manufacturing (Schoenberger, 1986; Hall, 1983), the acronym JIT finally emerged as the accepted term for

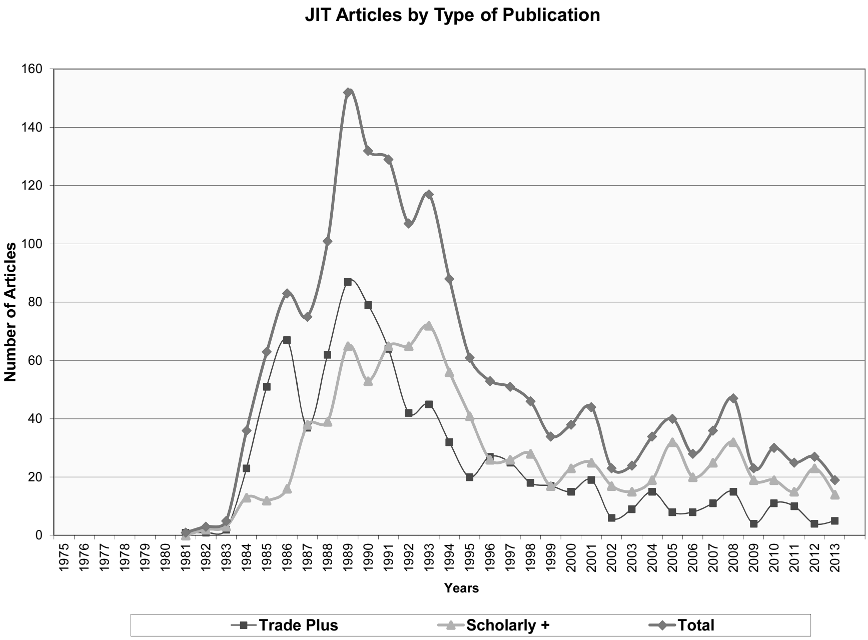

Figure 6A.1. Number of JIT articles.

describing this type of program. Its popularity grew rapidly during the 1980s and reached a peak about 1990. It gradually declined as Lean Manufacturing superseded JIT as the program of choice.

One of the earliest and most prominent adopters of JIT in the United States was Harley-Davidson. In 1981 and 1982, Harley had a critical quality problem and suffered losses that put the company's future in question. Japanese competitors had been making high-quality, low-cost motorcycles and eating into Harley's market share since the early 1970s. In 1982, Harley adopted JIT, and began to develop its program in-house, calling it Material as Needed (MAN). MAN was a combination of three factors: inventory reduction, statistical process control, and employee involvement. The program was implemented with little change in layout and no expensive supporting programs. MAN was a success, evidenced by several factors. Among them, inventory was reduced by 50%, inventory turns increased from five to seventeen, warranty claims decreased, the supplier base was reduced by 30%, and productivity increased by 32% (Sepehri, 1987).

Another case is Ambrake Corporation which produces high-quality, precision brakes. Ambrake's JIT program was made up of three pillars:

hardware (equipment design and cellular manufacturing), software (information systems), and "humanware"—this last one being the most essential of the three. Ambrake built its humanware foundation with four elements listed below.

- Education and training about JIT and continuous improvement
- Cooperative environment development through teamwork
- Job enlargement
- Open communication, respect, and trust among all levels of associates. (Gupta, Holladay, & Mahoney, 2000)

Both companies have emphasized that a continuous striving for improvement was the key to their success, and that this ideal should be ingrained in each existing employee and sought in each new one.

Expected Benefits (Tangible and Intangible)

The main general benefits of JIT include these improvements in the flow of goods:

- *Reduced setup time.* Cutting setup time allows the company to reduce or eliminate inventory for "changeover" time. The tool used here is SMED (single-minute exchange of dies).
- *The flow of goods from warehouse to shelves improves.* Small or individual piece lot sizes reduce lot delay inventories, which simplifies inventory flow and its management.
- *Employees with multiple skills are used more efficiently.* Having employees trained to work on different parts of the process allows companies to move workers where they are needed.
- *Production scheduling and work hour consistency synchronized with demand.* If there is no demand for a product at the time, it is not made. This saves the company money, either by not having to pay workers overtime or by having them focus on other work or participate in training.
- *Increased emphasis on supplier relationships.* A company without inventory does not want a supply system problem that creates a part shortage. This makes supplier relationships extremely important.
- *Supplies come in at regular intervals throughout the production day.* Supply is synchronized with production demand and the optimal amount of inventory is on hand at any time. When parts move

> directly from the truck to the point of assembly, the need for storage facilities is reduced. (Wikipedia, 2011)

Other more specific benefits include:

- Inventory reduction, which often provides opportunities for more capacity
- Improved overall lead time
- Higher quality products, leading to reductions in scrap and rework
- Greater overall efficiency
- Improved employee morale and job satisfaction
- Improved on-time performance
- Higher productivity coupled with decreased manufacturing costs

In general, JIT is concerned with the reduction of waste in all forms and the smoothing of the flow of goods throughout all of the production processes.

Barriers to Acceptance

JIT is not without its critics. Early articles on JIT printed in the United States—and many after it—argued that JIT wouldn't work in the West as it had in Japan, citing cultural differences like Eastern attention to detail, neatness, and collective goals accomplished at the expense of individuality. Also, managers who push their companies into JIT for the sake of fashion or short-run financial pressure will find more obstacles than those who employ a slow and thought-out plan. Some argue that a demand-pull system is risky because it is more difficult to accurately forecast future demand, especially in periods of uncertain economic conditions.

One of the most common complaints of JIT adopters is the difficulty of working with suppliers; convincing them to make small, frequent deliveries on short notice often proves to be impossible. Another complaint is that moving from large batches to continuous flow will automatically outdate most traditional cost accounting systems and require new ways to communicate production measures internally.

Implementation Approach

Often the first and largest challenge to a new JIT program is converting suppliers from large, periodic deliveries to small, frequent deliveries of extremely high quality goods. Below are solutions that companies have found useful toward this end:

- Locate suppliers nearby for delivery responsiveness. Some companies have even provided for on-site locations for suppliers.
- Monitor quality and consistency of incoming raw materials and set standards for suppliers.
- Limit the overall number of suppliers to create reliable relationships.

After achieving a new, more responsive relationship with suppliers, adjustments to the plant layout are often required to support continuous flow. Cellular manufacturing has been used in many JIT implementations. Cellular manufacturing involves identifying families of parts that are similar in ways like shape, size, stage of production, or conversion required. The most important trait that members of each family share is the machine(s) which they can pass through. After families and their requirements are identified, machines are grouped together to accommodate each family. Thus, a plant is divided into cells or factories within a factory. Each cell is then connected to each other by kanban systems, eventually ending with final assembly and shipping. Cellular manufacturing is credited with reducing or eliminating setup times, material handling, and overall throughput time—crucial issues in JIT. Since each cell acts like an independent factory, employees take responsibility of their cell and are encouraged to practice preventive maintenance, quality control, and to increase their autonomy. This human factor is also critical to a successful JIT implementation.

No two companies will have identical JIT programs, but developing reliable supplier relationships, adapting shop-floor layouts, and modifying the role employees are issues that have held companies back in the past, and so changes in these areas are necessary to gain the benefits of JIT.

Many of the costs of a new JIT program are up to the company itself. A company may choose to hire a consultant to facilitate the transition. They may also choose to invest in all new machinery and building improvements. However, JIT is meant to be a simple, back-to-basics approach to manufacturing, and any great expense or investment for the program itself would be counterintuitive. Like many management philosophies, the greatest investment is most often the time spent planning for changes, training employees, communicating with suppliers, and evaluating changes for signs of improvement. (Harvey, 1986)

Future

Over time, JIT has evolved into a philosophy of high-quality, low cost production with little to no reliance on inventory. Its popularity peaked in the 1980s and 1990s, after which its shine faded, allowing other management philosophies and fads to get their day in the sun. JIT principles were the genesis of some of these programs like lean and agile manufacturing, mass customization, and others. There are countless stories of companies and plants that have tried to convert to JIT production; some of them saw success, and some of them gave critics more to write about. There's a common theme among the success stories, however. Organizations like Harley Davidson that realized significant improvements in production didn't pick a JIT program off the shelf, but rather tailor-made one to their own unique specifications. Harley even renamed the philosophy: Material as Needed (MAN). In practice, companies do not choose to implement the entire philosophy at once, but rather apply a couple of individual principles that are directly relevant to their operations like cellular manufacturing or preventive maintenance. Later they might move on to inventory and supplier issues, or they might try to find other ways to make the internal process flows more efficient. This continuous process of improvement is in fact the cornerstone principle of JIT, and it is how the Japanese turned their economy around in the decades following World War II. Measurable improvement year after year is normal to American business, but JIT's fresh approaches to manufacturing and the often dramatic results are what made the philosophy garner the attention and study that it has.

Vokurka and Davis (1996) point out that the elimination of waste in manufacturing is an ongoing effort for successful companies. While JIT has been a recent driver in this effort, as a separate program, it is being assimilated into the normal operations of many companies. They summarize JIT in this way: "The concept of Just-in-Time has completed its evolution from a manufacturing technique to a much broader philosophy of improvement."

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CHAPTER 6B

LEAN PRODUCTION

NAME AND BRIEF DEFINITION

Lean Production—A philosophy of production that emphasizes the minimization of the amount of all the resources (including time) used in the various activities of the enterprise. It involves identifying and eliminating non-value-adding activities in design, production, supply chain management, and dealing with customers. Lean producers employ teams of multiskilled workers at all levels of the organization and use highly flexible, increasingly automated machines to produce volumes of products in potentially enormous variety. It contains a set of principles and practices to reduce cost through the relentless removal of waste and through the simplification of all manufacturing and support processes. Syn: lean, lean manufacturing (Blackstone, 2013).

Objectives (Reasons for Adopting Program)

Lean production has as its primary objective the elimination of waste and the creation of flow in the manufacturing process. It is similar to JIT in trying to reduce the variability in the process. Reduced variability leads to reduced inventories, faster response times, and improved quality. Manufacturing efficiency is adversely affected by the presence of manufacturing wastes and process variability adversely affects competitive manufacturing. Enterprise Resource Planning (ERP), Lean Manufactur-

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ing and Six Sigma are the three different strategies to address the above mentioned concerns for competitive manufacturing (Nauhria, Wadhwa, & Pandev, 2009).

One study that linked increased complexity with reduced manufacturing performance suggested that lean practices could reduce complexity (Bozarth, Warshing, Flynn, & Flynn, 2009). Other researchers proposed an extension to the normal value stream mapping approach in complex environments as a means of systematically analyzing the value stream (Braglia, Carmignani, & Zammori, 2006).

Lean production envisions input from all levels of the organization. When this is done, the organization can realize benefits. First, they create a "lean culture" of daily improvement. Second, they address improvement opportunities that are difficult for managers to spot. Third, they promote rapid organizational learning (Robinson & Schroeder, 2009).

History (Time Line, Reasons Originated, Principal Developers)

The term "lean" was first used by Womack, Jones, and Roos in their book *The Machine That Changed the World*, published in 1990. This book reported the empirical results of a survey of 90 automobile plants in Japan, the United States and Europe. They found that Japan far surpassed the United States and Europe in productivity and quality. Their conclusion was that Japanese companies practiced what the authors termed as "lean manufacturing" methods. Despite the fact that the just-in-time (JIT) manufacturing concept had been known for almost a decade prior, the book played a key role in disseminating the concept outside of Japan (Holweg, 2007).

Womack and Jones followed in 1996 with a book (*Lean Thinking*) that translated their empirical findings into management principles and concepts. Womack became a founder and major player in the Lean Institute. A number of consultants have joined in promoting the principles of lean production and Lean has replaced JIT in number of articles published. While most of the successful lean applications have been in manufacturing, the advocates are promoting extension of the concept to non-manufacturing areas such as distribution, retail and health care.

Figure 6B.1 shows the number of total articles written about lean production. The number of articles appears to have peaked about 2008 and has declined in recent years in trade publications, although the number of articles in scholarly journals has increased. This may be the result of more companies implementing lean production so that it is no longer necessary to write articles about it.

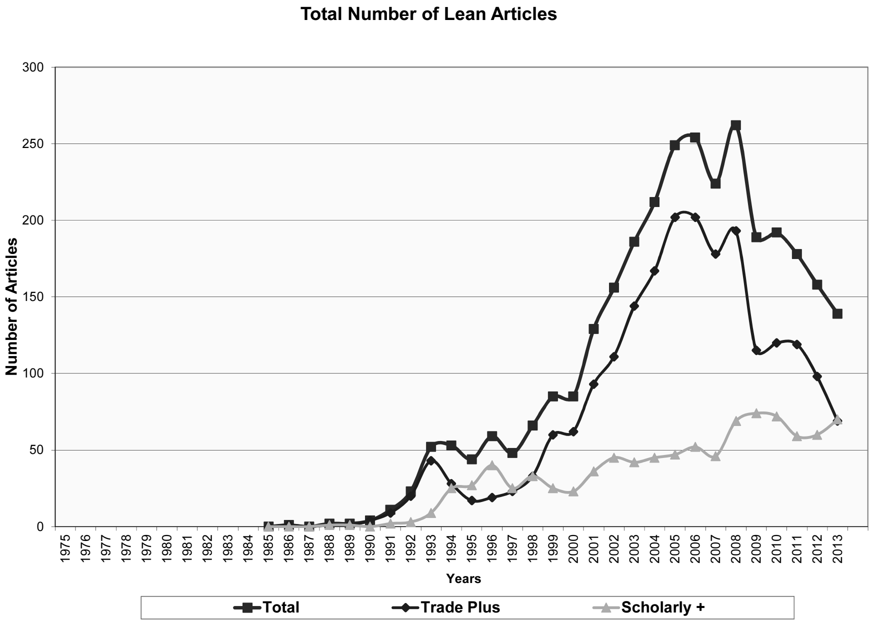

Figure 6B.1. Total number of Lean Production articles.

In recent years, there has been wider interest in combining learn manufacturing practices with other popular programs, such as Six Sigma, to form Lean Sigma programs to put emphasis on both costs and quality.

Expected Benefits (Tangible and Intangible)

The primary benefit expected from a lean manufacturing program is cost reduction, although a successful implementation program sets the stage for a number of secondary benefits, such as improved quality, faster response time, and increased flexibility and agility.

Lean manufacturing requires the reduction of inventories, especially work-in-progress (WIP) inventories, to smooth and accelerate the flow of goods and services through the supply chain. Consequently, Lean manufacturing requires the reduction of process variability. In order to reduce inventories without creating significant disruptions in product flow, product quality has to improve.

Often, longer lead times are caused by WIP inventories. With reduced inventories, lead times will decrease. With shorter lead times, it follows that a lean manufacturing environment should make it possible to be more flexible in responding to customer demands.

Lean can also provide benefits in new product development. Around 50% of the costs incurred in product development tend to be spent on wastes that occur during the New Product Development (NPD) process. Researchers have successfully applied lean manufacturing concepts to NPD and have eliminated waste, not only in the NPD process but also in preventing the emergence of waste once the product enters the manufacturing process (Anand & Kodali, 2008).

There are indirect benefits from a lean manufacturing program. A successful lean program requires discipline among employees to make sure that errors don't creep into the processes, both administrative and production. It also requires that employees communicate regularly to assure that small disruptions don't become large disruptions.

Build-to-order (BTO) and lean manufacturing processes are changing the paradigms under which businesses-to-business marketers operate. BTO processes allow marketers to customize products to a greater degree, creating a competitive advantage over traditional manufacturing. Business-to-business (B2B) marketers who take advantage of the operational efficiencies and effectiveness that emerge from BTO are outperforming firms that utilize traditional manufacturing processes in multiple industries, such as office furniture, personal computers, and windows (Sharman & LaPlace, 2005).

Barriers to Acceptance

One of the major barriers to successfully implementing a lean manufacturing program is that it takes a great deal of commitment at all levels of management. Top management must be willing to commit resources to the program; they must also become knowledgeable enough to understand that initial results may not always show immediate benefits. This is especially true with programs to reduce inventories. Often, in the early stages, inventory reduction may appear to have a negative effect on earnings, instead of the positive effects expected. This is because reducing inventory unleashes a flow of stored expenses into the current income stream, without a commensurate reduction in operating expenses, especially overhead expenses. However, when the focus is solely on inventory reduction, this excessive focus may lead to a less than satisfactory lean implementation (Gorman, Hoff, & Kinion, 2009).

In a relatively short period of time, companies have found they can achieve faster cycle times, reduced defect rates and sharp gains in on-time deliveries. But the transition takes time, and it is full of obstacles. One of the biggest and most predictable hurdles is the crisis in confidence that occurs when management is not able to improve financial performance quickly enough. When the numbers fall short of internal and external expectations, managers often try to modify the lean initiatives or abandon them altogether (Cooper & Maskell, 2008).

Another major barrier is the effect on employee job disruption and elimination. If lean manufacturing is to be successful, there must be a reduction in the number of employees. The only way to prevent this is to use the displaced employees to produce products required to handle additional new business. Most lean manufacturing advocates recommend settling the question ahead of time to be sure that employees know what to expect if they participate in a program that will likely affect their own jobs. Lean production has work design characteristics, such as autonomy, task identity and skill variety, and employee outcomes (Mehta & Shah, 2005).

Measuring the effect of lean production can be difficult. Inventory levels are not in themselves a measure of performance. Every manufacturer has its own individual key performance indicators (KPIs), and there is no single perfect set of supply chain metrics. Nevertheless, one common measure has emerged in recent years: the cash-to-cash cycle time (Blanchard, 2009).

Johnson (2006) goes even further in identifying measurement as a problem by stating: "Accounting control systems have been the number one enemy of sound operations management in American business for at least 50 years. Accounting control systems play no role in Toyota's operations; the company focuses on lean manufacturing. This absence of accounting controls, like the absence of external production controls in Toyota's shop floor operations, is virtually incomprehensible to the average person trained in American business schools or employed in American businesses since the 1950s. In terms of the subject of lean accounting, it is argued that the widespread use of accounting control systems to drive operations in businesses rests on an erroneous belief that financial or other quantitative targets can be used to explain, motivate, and control financial results in a business. Knowledge of what produces results requires one to understand relationships, systemic interdependencies, and internal feedback of the sort that stabilizes and controls a living system. That understanding cannot be achieved by studying quantitative accounting data." Maskell (2006) expands on this theme by pointing out that when a company moves to value stream management, the simple methods of value stream costing become much more useful than the traditional standard or detailed actual costing methods. Just as standard product costing (and the related activity-based costing) was the costing method for mass production, so value stream costing is the primary financial reporting method for lean organizations.

While the lean manufacturing concept has been around for two decades, there may still be a lack of clarity about it. Overall, it can be concluded that lean production is not clearly defined in the reviewed literature. This divergence can cause some confusion on a theoretical level, but is probably more problematic on a practical level when organizations aim to implement the concept. It is important for an organization to acknowledge the different variations, and to raise the awareness of the input in the implementation process. The organization should not accept any random variant of lean, but make active choices and adapt the concept to suit the organization's needs. Through this process of adaptation, the organization will be able to increase the odds of performing a predictable and successful implementation (Petersen, 2009).

Implementation Steps

Womack and Jones (1996) outline the following steps in implementing a lean manufacturing program. They stress the primary objective is to Eliminate muda, or waste in an organization. Waste is any human activity which absorbs resources but creates no value. Taiicho Ohno, at Toyota, pioneered the elimination of waste. The antidote to waste is lean thinking which, in contrast to reengineering, provides a way to create new work rather than simply destroying jobs in the name of efficiency. Examples of waste include:

- Mistakes which require rectification
- Production of items no one wants
- Processing steps that aren't needed
- Movement of employees and transport of goods without purpose
- Groups of people waiting for work from others
- Goods and services that don't meet the needs of the customer

Implementing a lean manufacturing program involves the following steps (Womack & Jones, 1996):

1. **Specify Value**. The critical starting point for lean thinking is value. Value can only be defined by the customer. The definition of value is skewed by the power of preexisting organizations, technologies, and undepreciated assets, along with outdated thinking about economies of scale.

2. **Identify the Value Stream**. The *value stream* is the set of all the specific actions required to bring a specific product through the critical tasks of any business. Actions along the value stream should include the value adding steps but eliminate the non-value added steps. Lean thinking must go beyond the individual firm to the entire set of activities, the value stream.
3. **Establish flow along the value stream**. Once value has been precisely specified and the value stream fully mapped and cleared of wasteful steps, the remaining value-creating steps must be made to flow. The concept of large lot sizes, to gain efficiency, must give way to the benefits of flow. Flow differs from reengineering. Reengineering creates disconnected and aggregated processes and often destroys morale among employees.
4. **Create Pull from downstream customers**. The first visible effect of converting from departments and batches to product teams and flow is the reduction of lead times. Reduced lead times makes it possible to convert from a MTS to a MTO environment, or let the customer pull the product. Pull will lead to mass customization.
5. **Aim for Perfection**. When companies specify value, identify the value stream, create flow, and let customers pull value, it becomes easier to view perfection as a reasonable goal. Transparency, the ability to see everything along the supply chain, is an important spur to perfection. Future improvements will depend on being able to work smarter, not harder.
6. **The Potential Payoff**. Rules of thumb improvements in converting to lean production include: Double labor productivity, reduce throughput times by 90%, reduce inventories by 90%, reduce errors and scrap by half, reduce time-to-market by half, and capital investments will be modest. Traditional thinking about economic growth focuses on new technologies and additional training and education as the keys. Most of the economic world is a brownfield of traditional activities performed in traditional ways. Lean thinking and the lean enterprise is the solution.

Future

Lean manufacturing has been successfully implemented in a number of manufacturing organizations. A number of service organizations have also explored the use of lean techniques, especially in the health care field (Kolberg, Dahlgaard, & Brehmer, 2007). Healthcare management needs an overhaul. The same problems that have plagued the American auto industry plague American healthcare. Lean is really about having front-line workers design and improve the standard work. Developing a culture of continuous improvement by changing the way leaders practice and behave is critically important (Toussaint, 2009). As service companies learn that lean manufacturing techniques can fit their organizations, they will more actively pursue its use. Another study demonstrates its use in a sales operation (Barber & Tietje, 2008).

Recently, lean techniques have moved from manufacturing plants to operations of all kinds, everywhere: insurance companies, hospitals, government agencies, airline maintenance organizations, high-tech product development units, and retail buying groups, to name a few. The biggest challenges in adopting the lean approach in nonindustrial environments are to know which of its tools and principles to use and how to apply them effectively. As the lean approach expands into wider circles of operations, it ceases to be about best practice and starts to become part of the fabric of doing business (Corbett, 2007).

Lean manufacturing is also being combined with other management programs, especially quality program, such as Six Sigma (Bossert et al., 2002; Brown, Collins, & McComb, 2006). Some suggest that lean can be combined with agility programs, to form leagile capabilities (Krishnamurthy & Yauch, 2007; Mistray, 2005; Narasimham, Swink, & Kim, 2006). Another study concluded that TQM, JIT and TPM should be combined under the umbrella of Lean manufacturing to form an integrated manufacturing program (Cua, McCone-Sweet, & Schroeder, 2006).

Lean manufacturing has been successful in individual companies. The next step is to use the techniques along the supply chain. This goes beyond just organizing a supply chain; it requires that lean techniques be implemented by supply chain participants and even in the interfaces between participants (Levy, 1997; MacDuffie & Helper, 1997).

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CHAPTER 6C

BUSINESS PROCESS REENGINEERING (BPR)

NAME AND BRIEF DEFINITION

Business Process Reengineering (BPR)—A procedure that involves the fundamental rethinking and radical redesign of business processes to achieve dramatic organizational improvements in such critical measures of performance as cost, quality, service, and speed. Any BPR activity is distinguished by its emphasis on (1) process rather than functions and products; and (2) the customers for the process. Syn: reengineering. (Blackstone 2013).

Objectives (Reasons for Adopting Program)

Business Process Reengineering—also widely known as "Reengineering"—generally involves a radical change within a business. The need for change may be motivated by critical problems that a company faces, such as overwhelming customer complaints or rising costs. Or a company may seek change as it positions itself for growth. Whatever the driving force, a business that looks seriously into reengineering a business process is growing critical of that process and wants to seek a better way. In short, a BPR program aims to create new success factors for a business or particular process and then start from scratch to build a new process design that emphasizes those factors. Generally, old success factors like machine utilization and direct labor productivity are traded for less quantifiable objectives like information utilization, customer satisfaction, quality, flexibility,

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and timely service. In designing an improved process, practitioners are encouraged to use a clean slate—to brainstorm and abandon any recollection of the current process. This is to aid creative thinking and avoid false notions of constraints related to the old way of doing things.

In his *Harvard Business Review* article, Hammer (1990) outlined seven major components of ideal processes. They emphasize worker autonomy, information technology, and the combination of previously separated process steps:

- Organize around outcomes, not tasks. Use job enlargement so that one person is responsible for as many process steps as possible. An example is a customer service representative or a case manager.
- Have those who use the output of a process perform the process. An example would be to guide customers through simple repairs over the phone or have a particular department make their own purchases with decision-making tools like expert systems.
- Have those who produce information also process it. Ford had receiving verify the accuracy of an order by checking it against an outstanding one in the database instead of sending the invoice to purchasing.
- Treat geographically dispersed resources as though they were centralized. Use databases and telecommunication networks to achieve the benefits of scale associated with centralization in addition to the increased flexibility provided by several different locations.
- Link parallel activities instead of integrating their results. In product development, instead of trying to save time by having three different teams develop three different parts only to have them fail to work together at the integration phase, have one team develop and test the product together.
- Put the decision point where the work is performed and build control into the process. Rather than controlling by separating duties, increase the autonomy of a typical worker and program controls into the information system.
- Capture information once and at the source. Obviously, redundant data entry is inefficient and prone to error. Shared databases are an easy way to apply this technique.

History (Time Line, Reasons Originated, Principal Developers)

In 1990, Michael Hammer is generally credited with introducing the concept of radical process reengineering in an article called "Reengineering Work: Don't Automate, Obliterate." in the *Harvard Business Review.* Note: Thomas Davenport also reported that the basics of reengineering had its roots in information technology research of earlier decades. (Davenport, 1994) Shortly thereafter, Hammer co-wrote *Reengineering the Corporation* with James Champy and started his own consultancy as an educator of reengineering concepts for executives. By 1992, BPR was an increasingly popular idea among businesses although the concepts were vague and limited to Hammer and Champy's writings. Within a few short years, reengineering was at its peak, the subject of a number of books and numerous seminars, articles, and lectures.

However, with fame came increasing criticism. For some companies, reengineering worked, and there were outstanding results to show for it. Yet, many companies either abandoned their BPR efforts before implementation or had only mediocre results to show for months of work. The Wall Street Journal reported that Hammer conceded that the original concept didn't adequately consider the human element in implementing major changes. (White, 1996) By 1997, BPR was losing favor in the business community. Large-scale radical change had proven to be too great a leap of faith for many managers. BPR had become synonymous with downsizing, although reengineering had been successful in a number of organizations. "But this new process view of organizations has not yet been fully realized. Many companies have integrated their core processes, combining related activities and cutting out ones that don't add value, but only a few have fundamentally changed the way they manage their organizations" (Hammer & Stanton, 1999).

After the turn of the millennium, BPR made a comeback, although not under the same name. Enterprise Resource Planning (ERP), Supply Chain Management (SCM), and Customer Relations Management (CRM) are all broad forms of BPR because they seek to use technology to streamline business processes—but this time, the processes extend well beyond company walls to include the supply chain and end customers. (Clermont, 2001) James Champy coined the term "X-engineering" to describe a similar philosophy. X-engineering—the X stands for the crossing of boundaries—was received with mixed reviews, but the other reincarnations of BPR have experienced measurable success (Champy, 2002).

Figure 6C.1 shows the number of articles published with BPR the main theme of the article. Prior to 1992, it didn't carry the acronym BPR and appeared primarily under the title of "Reengineering." The number of articles peaked in the 1990s and has declined steadily since, with most of the articles appearing in scholarly journals. As a separate topic, BPR has not received much attention in trade publications recently.

Any process where inputs enter a system and later exit as output or deliverables is conceivably a candidate for BPR. This obviously covers the

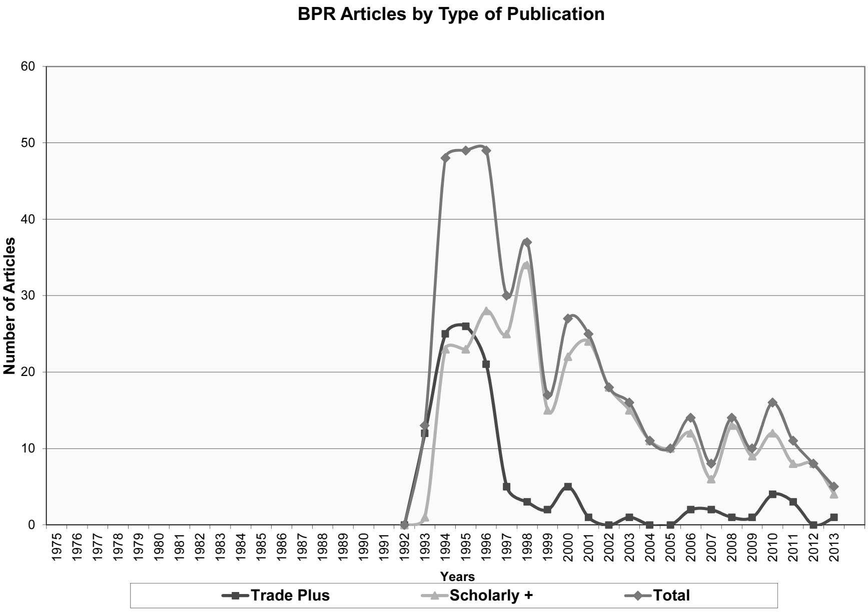

Figure 6C.1. Total number of BPR articles.

spectrum of industries from manufacturing to service, large to small, as well as the full range of business functions within an organization. Most of the processes targeted for reengineering were ones whose age dated before the spread of sophisticated information technology (i.e., the early 1990s). Below are other signs that led companies to believe that reengineering was appropriate:

- New technology is not being fully utilized.
- Customers or other departments can't get a timely response to inquiries.
- Approval for action must come by more than one step.
- At any given time, one department is idle, waiting for another to take action.
- Employees follow some procedures only because "it's always been that way."
- Too much time is devoted to activities that don't add value.

Expected Benefits (Tangible and Intangible)

The greatest benefit that a successful BPR initiative provides is a revived, drastically improved business process and thus, a greater competitive advantage. More specific benefits might include the following:

- Less process errors leading to improved product quality.
- Dramatically shortened cycle times leading to increased productivity.
- Job redesign and greater employee autonomy increasing overall employee morale.
- Efficient processes and technology utilization reducing costs.

An example of change is the way in which Texas Instruments' calculator business used process reengineering to design a multidiscipline approach by using teams of people from engineering, marketing, and other departments to work together in designing new products. In order to do this, they had to change the organization to fit the new process. The development teams became the primary organizational units. The results included a 50% reduction in time to develop new products and an 80% reduction in breakeven points. In addition, the unit became a market leader (Hammer, 1999).

Barriers to Acceptance

Much has been written about the shortcomings of reengineering as a management philosophy. The largest complaint is that reengineering just does not work for most companies. Even the BPR guru Hammer reported that many companies have successfully implemented "process management" initiatives while other companies failed to yield significant results. As Hammer explains, "In spite of their intentions and investments, many have made slow or little progress. Even businesses that succeeded in transforming themselves have found the endeavor arduous and harrowing. All change projects are tough to pull off, but process-based change is particularly difficult." (Hammer, 2007, p. 112) Project failures have been explained by a variety of reasons:

- Many BPR programs failed or were abandoned because of intense employee and management resistance.
- Newly designed processes are often too expensive to be feasibly implemented.
- If they aren't too expensive, the new projects might be too abstract for senior management to accept and endorse. If executives can't make the required leap of faith, or if they can't be committed to supporting the project, reengineering is bound to fail.

- One of the objectives of reengineering is to utilize technology. Sometimes, a new process relies so heavily on technology, that a server crash or other IT problem brings the entire process to a halt.

Process reengineering is a radical change that some companies find is overwhelming.

Implementation Approach

BPR projects usually involve big changes, ones that only executive management really has the authority to implement. The changes may come in capital, infrastructure, personnel, or something else entirely; whatever the case, executive management should steer the BPR project at all times to approve or implement decisions beyond the scope of project team members' authority. The process improvement team should be cross-functional, with representatives from across the company.

The first phase is one of research. Below are some issues addressed during the research phase:

- Diagnose the current situation by gleaning feedback from customers. Determine what factors are most important to customers, and recognize these as the new critical success factors.
- Analyze the company's position among competitors and determine how other companies perform on the critical success factors.
- Document current process flows, determine which processes have the most room for improvement, and select one or two to pursue. Many BPR failures stemmed from attempts to overhaul several business processes at once.
- Name a process owner for those selected for improvement. It should be one who understands the entire process, benefits from its success, and has the authority to change the process.

The next phase is the design phase. With a clean slate, the process improvement team brainstorms new processes that accomplish the goals of the system, keeping in mind the critical success factors. The best solutions are often not economically feasible because they require heavy investments in new equipment, software packages, or locations. Some businesses found that designing with a "dirty slate" was helpful in this respect. Instead of totally ignoring the existing system, team members factor in certain elements that would be difficult to replace or do away with. During the design phase, the team also plans the phases of implementation as well as de-implementation, to be used should the project prove unsuitable.

Finally, the implementation plan is carried out. Although BPR is famous for radical, overnight change, the cautious would be wise to adopt a slow, thought-out plan while carefully managing the transition among personnel. Even Ford's accounts payable reengineering took five years to fully implement.

An ongoing part of BPR is evaluation. Years down the road, changing conditions or new technology may give cause for another reengineering effort, but to recognize that a process's usefulness has run its course requires constant monitoring. Also, internal performance reports may also require redesigning, to reflect the new critical success factors. Cycle time may have become a higher priority than machine utilization, and internal reports should reflect that.

BPR asks a few important questions: What are the inputs and desired outputs of this process? Ignoring our existing condition, what is the most efficient way to consistently produce these outputs? How do we get there? The answer may involve new software, new equipment, or even a new location. Obviously, this can be very expensive. Throughout its popularity, BPR often proved to be more expensive than it was worth to executives, which is one reason so many projects were abandoned before implementation. Although the end result was cost-efficient, the means to get there were anything but.

Dirty slate design, as opposed to clean slate design, can minimize some of these costs by identifying a few things that *can't* change from the old process to the improved one. Also, the design phase can be encouraged to creatively come up with several different solutions, increasing the chance that at least one of them will be affordable.

Hammer (2007) outlines a new framework, called the Process and Enterprise Maturity Model (PEMM) for helping companies plan and implement process transformations. He provides a comprehensive explanation of his model in the article.

Future

It can be safely stated that the fervor that surrounded BPR in the early and mid-1990s was equal to the backlash that later condemned it as a business practice. This is largely due to the high proportion of companies who saw insignificant results, or worse, found that the cure was worse than the disease. To understand why BPR was so popular is to understand why it was necessary. Technologies such as shared databases, expert systems, and electronic data interchange (EDI) were becoming more commonplace in the early 1990s. These applications had the potential to automate many of the tasks that could only be done by hand previously, thus radically changing business itself. Yet companies were not fully utilizing technology's benefits, preferring to hold on to old processes that were growing more inefficient by the day. Business Process Reengineering was a wake-up call for these companies. Their competitors were struggling with the same technology issues, and the first company to reengineer and align their processes with the new technology would undoubtedly capture unprecedented market share. Thus, reengineering fever was born. As its popularity grew, implementations grew less artful and more harried, and failures became common.

Employees are often averse to new technology because it threatens their jobs. At the peak of the BPR craze, many discovered that this fear was completely justified because a redesigned process had just replaced them with a database. Even as the founders of BPR insisted that companies not neglect their human resources, reengineering became synonymous with layoffs. Downsizing is a quick way to cut costs, but long-term growth is better served by shifting those positions that technology replaced into areas that reflect the new critical success factors like customer service and quality.

"Successful BPR can potentially create substantial improvements in the way organizations do business and can actually produce fundamental improvements for business operations. However, in order to achieve that, there are some key success factors that must be taken into consideration when performing BPR. BPR success factors are a collection of lessons learned from reengineering projects and from these lessons common themes have emerged. In addition, the ultimate success of BPR depends on the people who do it and on how well they can be committed and motivated to be creative and to apply their detailed knowledge to the reengineering initiative. Organizations planning to undertake BPR must take into consideration the success factors of BPR in order to ensure that their reengineering related change efforts are comprehensive, well-implemented, and have minimum chance of failure." (Wikipedia, 2014)

BPR is meant to bring fast, dramatic results whereas continuous improvement initiatives like TQM favor small, long-term improvements. However, a lesson to be learned from BPR failures is that quick, haphazard change programs aren't likely to succeed. Reengineering a process may be the best solution for a company—it may even be a necessity—but it should be carefully planned and implemented for best results.

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CHAPTER 6D

BUSINESS PROCESS OUTSOURCING (BPO)

NAME AND BRIEF DEFINITION

Business process outsourcing. Contracting with third parties to perform non-core activities within a business. Functions often outsourced include human resources, accounts receivable, accounts payable, and payroll. (Blackstone, 2013)

Outsourcing. The process of having suppliers provide goods and services that were previously provided internally. Outsourcing involves substitution—the replacement of internal capacity and production by that of the supplier. See: subcontracting. (Blackstone, 2013)

This version extends outsourcing to both goods and services. Although not stated in the above definition, outsourcing can be to either domestic or foreign suppliers. Outsourcing is also called business process outsourcing (BPO). We will view outsourcing from the U.S. perspective; however, it is a global issue. For example, IT outsourcing grew faster in Europe in 2003, with preferred suppliers in Eastern Europe, than in the United States, with preferred suppliers in India (Gibson, 2005).

Is outsourcing a trail of broken promises or the new path of modern management? It depends on your point of view. One observer believes that "Most people have made up their minds about these topics and aren't open to different points of view. Some people think outsourcing is a wonder of a free-market economy; others see in it nothing more than an immoral disregard for loyal employees" (Gibson, 2005). For a business, it

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may depend on whether it is just trying to save the next quarter's results or design and nurture relationships that will help the company survive and prosper in the future.

Objectives (Reasons for Adopting Program)

What are the drivers of outsourcing? While anticipated lower cost may be the primary driver, there are others, such as added capacity, technical knowledge, and perceived simplification of the remaining slimmer organization. The last may not be a realistic expectation. "What outsourcing does is trade the hassles of managing information technology and networking operations for the hassle of managing alliances" (Gantz, 1990).

What are some of the factors to consider in the analysis to outsource? King (2000) proposes a model that includes (1) Short-range Operational Impacts, such as efficiencies, cost savings, productivity and service levels; (2) Mid Term Tactical Impacts, such as performance, control and risk sharing; and (3) Long-range Strategic Impacts, such as developing core competencies and learning competencies. This model emphasizes that the decision to outsource has long-term implications. Davidson (1990) cautions that the best form of organizational structure for outsourcing may not evolve for years. A list of more (but not exhaustive) detailed decision criteria could include: Short-term costs versus long-term value, lack of skills in the United States, quality of product or service, delivery time, customer attitudes, social acceptance, loss of in-house capability, need for project management skills, effect on political image, and effect on national security. Whatever the criteria, the decision is a complex one.

Companies increasingly view outsourcing as a strategic decision, not a tactical decision. As a result, they consider the impact of the decision over a longer time horizon and include a greater number of factors in making the decision.

History (Time Line, Reasons Originated, Principal Developers)

Outsourcing is not new. On the manufacturing side, the "make or buy" decision has long been a basic consideration. On the services side, all types of companies have outsourced such business support functions as food and custodial services. As technology improved to facilitate global communications, it was possible to outsource call centers and help desks. Then companies found they could hire well-trained persons to write programs. The list goes on to include medical technicians to read your X rays, accountants to prepare your taxes, even business journalists to interpret companies' financial statements (Thottam, Tumulty, & Rajan, 2004).

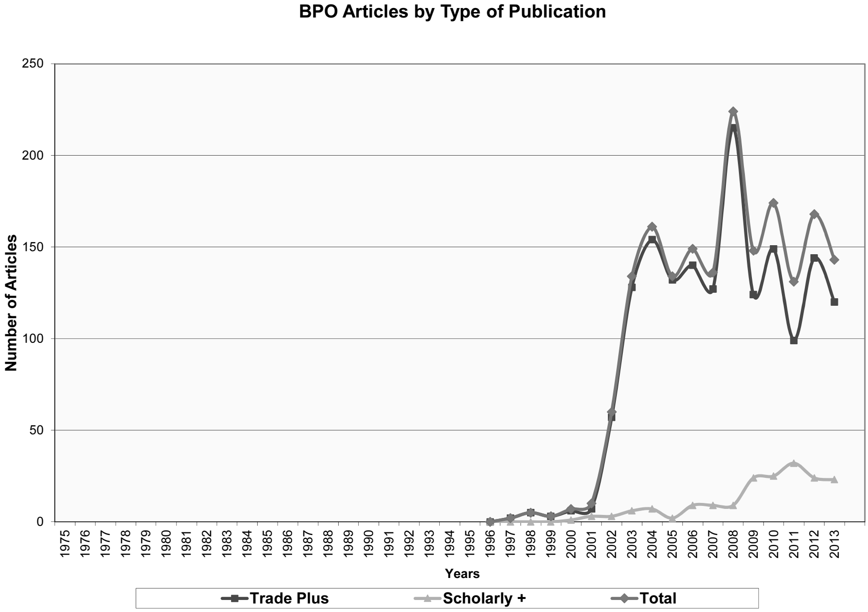

Figure 6D.1. Total number of Business Process Outsourcing (BPO) articles.

However, there are growing pains in outsourcing. The Aberdeen Group (Enslow, 2005), in a survey of 170 companies, found that "The biggest challenge for companies going global is how to keep the supply chain moving without exploding the sourcing savings or sales opportunity that enticed them to go global in the first place. This requires synchronizing logistics, compliance, and finance processes." Over 90% of the companies felt pressure to improve their global trade process because: (1) lead times are inhibiting their ability to respond to market demands; and (2) expected product cost savings are being eroded by unanticipated global supply chain costs. Deloitte also found that a number of companies experienced unsatisfactory results in their outsourcing projects (Landis et al., 2005). The pressure is not to forsake outsourcing but to establish an integrated system of outsourcing that more carefully selects and manages the outsourced projects.

Figure 6D.1 shows the total number of articles written about business process outsourcing (BPO). It began receiving attention in the late 1990s and has become a more popular topic during the first decade of the twenty-first century. While there has been an increase in the number of scholarly articles, trade publications remain the dominant source for information about BPO events.

Expected Benefits (Tangible and Intangible)

As the business environment becomes more complex, it is increasingly difficult for a company to be sufficiently competent in all facets of a business. Therefore, they must seek help from more qualified sources. Yuva and Trent (2005) offers the following reasons for going global: (1) To gain a global perspective; (2) The cost/value benefits; (3) Greater access to product and process technology; and (4) To facilitate the transition from selling to buying in a region.

The most obvious benefit is a reduced cost of product or service. An additional direct benefit is the reduced need for capital investment in equipment and facilities. Offsetting these direst benefits are the increased cost and time to transport goods from an offshore location.

There is a caveat, however. Considering it does not imply an automatic affirmation to outsource. It is a complex decision that requires both a good decision-making process that is systematic and comprehensive to supplement good judgment. Outsourcing is far from a "no-brainer" decision. The decision to outsource should follow a comprehensive analysis, rather that reacting to short-term considerations (Yuva & Trent, 2005; Gottfredson, 2005; King, 2000).

Barriers to Acceptance

The initial barrier to outsourcing was primarily a result of displacing employees, either by dismissal or transfer to another job within the company. As outsourcing affected larger numbers of employees, unions and other social-awareness groups became more vocal in their criticism of companies doing the outsourcing. However, the financial attractiveness of outsourcing was so great that many companies elected to move ahead with their programs despite the negative reactions of the public.

In recent years, quality and delivery issues have made outsourcing a more unreliable alternative. Product contamination—tainted milk, lead-paint toys and chemical-laden carpets have caused many consumers to become more aware of the product's source. Uncertain deliveries, sometimes accentuated by earthquakes, tsunamis and nuclear disasters, have caused significant disruptions in the supply chains of major industries, such as automobiles and airplanes.

Rapidly rising wage rates in source countries, such as China and India, have reduced the financial advantage of outsourcing. In some cases, this is leading to a growing wave of nearsourcing (changing suppliers from China to Mexico) or even insourcing (bringing the activity back to the company's domestic location.

While outsourcing continues to be an attractive alternative, it is being approached with more deliberation and farsightedness than before. There are more companies who indicate they are at least considering reshoring, bringing back the outsourced operations to the home country, or nearshoring, moving to a closer supplier.

Implementation Approach

Once all of the decisions outlined above are made, there remains the actual outsourcing of the product or service. There are many companies eager and able to help in this phase of the work. Selecting one, or more, of them to help is a major project in itself, and well beyond the scope of this brief description. The Outsourcing Institute is a good place to start. (www.outsourcing.com) Some of the key questions to be explored include the following.

What Should We Outsource?

Companies continue to reduce the scope of support functions performed internally. After food and custodial services came payroll. Next came human resource functions such as employee testing and screening. Today, the focus is on information technology. Many companies no longer consider these support functions as core competencies.

At what point does the concept of "preserve the core competencies" fall apart? While the consensus among researchers is that preserving the core competencies of the firm is important, they don't agree on how to determine the core. Some even suggest that R&D is not beyond the reach of the outsourcers (Engardio & Einhorn, 2005).

At any rate, companies will become more selective in "what" they outsource. The question will not be just whether to outsource; it will be what and to whom.

When Do We Outsource?

As part of the longer-range perspective, more companies will consider what their costs could be if they implemented continuous improvement programs, such as JIT, lean production, Six Sigma, and supply chain management. With internal improvements, outsourcing may not be as attractive.

Some advocate taking careful stock of your processes before deciding to outsource. For example: The classic paradox of outsourcing is that businesses are often told not to outsource their problems. But if a process is running smoothly, then why outsource it? Many times, the better a process works internally, the more money you are likely to save by outsourcing it, because the transition will be simpler, allowing the outsourcer to focus more on optimization. So, how do you decide which processes are best suited for BPO now? It depends on two factors: deciding which ones have the least strategic value to your company, and then evaluating which of those processes are in the best shape. (Moore, 2005)

Where Do We Outsource?

Outsourcing does not always mean global or offshore outsourcing. A company should always first consider making the product or performing the service. Next, to capitalize on the convenience of proximity, they should consider domestic suppliers. Only then should they look to offshore suppliers.

In making the decision, companies balance the tangible benefits of offshore outsourcing, such as lower costs and increased capabilities, with the increased risks and uncertainties of doing business with remote suppliers.

To Whom Should We Outsource?

Should a company distribute their outsourced products or services among a number of suppliers to lessen the risk of losing intellectual property or concentrate its outsourcing in a few, or even one, company? Some major consulting companies are gearing up to provide integrated services. IBM announced a new emphasis that would enable them to offer complete management services in such diverse areas as finance, human resources and customer service (Hamm, 2005). This decision boils down to a choice between spreading and concentrating risk.

As businesses outsource services, the remaining organization becomes more streamlined. While streamlining may suggest that it is simpler, it is not. The relationships, both within the business and between internal and external entities become more complex and require attention to assure satisfactory results. Davidson, (1990) emphasizes that the human resource function is necessary to help in the outsourcing program by providing help in internal organization realignment and coordination of the strategic alliances formed by outsourcing. This requires greater coordination among the involved entities.

The role and scope of the purchasing function will change significantly. It will have greatly increased responsibilities for internal and external coordination of the various outsourced projects. As the amount of outsourcing increases, some businesses will probably create an "Outsourcing" function within the organization with greater cross-functional responsibilities, perhaps initially a part of the purchasing but eventually a more senior level function responsible to top management.

The information technology function is necessary in the outsourcing program to provide help in setting up the electronic communication and interorganizational interfaces necessary for outsourcing. It also means that some elements of the information technology function should be retained, not outsourced.

Some recommend a regular (annual or at the end of a contract) review to reevaluate the effect of economic and political changes, as well as the vendor performance (Yuva & Trent, 2005). Others suggest that the reviews should be often enough to prevent the loss of in-house critical resources and competencies (Gottfredson et al., 2005). Companies should view outsourcing as dynamic, not a "one and done" kind of decision.

Future

The outsourcing trend will continue in the United States; however, many companies are being more cautious and some are recalling outsourced work because of unsatisfactory results (Landis et al., 2005).

Extensive outsourcing will require a major restructuring of the purchasing, or procurement, function. Purchased services will increase as a percentage of the total costs and their composition will increase in complexity. It will take a multi-functional team to effectively manage the outsourcing programs (Venkatesan, 1992).

Project managers, and project management skills, will become increasingly important. While some in-house projects can be monitored and modified informally, outsourcing requires the formal coordination of functions and tasks, both internal and external.

While politicians lament the trend, it appears unlikely that the federal government will do anything substantial to stop the outsourcing movement (Gibson, 2005). While there may be short-term hurdles, there will not be permanent barriers.

U.S. companies will continue to outsource, but at a more deliberate pace as they move up the learning curve. Companies will view outsourcing as a management function and will learn to analyze, plan, manage, evaluate and control the process. When appropriate, outsourcing will become a core function of a business.

ACKNOWLEDGMENT

A portion of this description of BPO was adapted from Crandall, R. E. (2005). Device or strategy? Exploring which role outsourcing should play. *APICS Magazine, 15*(7), 21–23.

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CHAPTER 6E

VALUE ANALYSIS AND VALUE ENGINEERING

NAME AND BRIEF DEFINITION

Value analysis (VA)—The systematic use of techniques that identify a required function, establish a value for that function, and finally provide that function at the lowest overall cost. This approach focuses on the functions of an item rather than the methods of producing the present product design (Blackstone, 2013).

Value engineering (VE) and/or analysis—A disciplined approach to the elimination of waste from products or processes through an investigative process that focuses on the functions to be performed and whether such functions add value to the good or service (Blackstone, 2013).

Value management (VM)—Is concerned with improving and sustaining a desirable balance between the wants and needs of stakeholders and the resources needed to satisfy them. Stakeholder value judgments vary, and VM reconciles differing priorities to deliver best value for all stakeholders. VM is based on principles of defining and adding measurable value, focusing on objectives before solutions, and concentrating on function to enhance innovation. It uniquely combines within an integrated framework a value focused management style; a positive approach to individual and team motivation; an awareness of the organizational environment; and the effective use of proven methods and tools (Institute of Value Management, 2013).

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 175–182
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Value analysis, a program to enhance product value and quality, has evolved into value engineering (VE) and, more broadly, into value management (Modic, 1990). Value analysis was largely focused on purchasing; however, it has expanded its scope to include multi-disciplinary teams from all of the functional areas of an organization. It has also moved from being focused on products after they were designed to a focus on the product design to avoid unnecessary cost.

Value is a somewhat nebulous term. Miles defined it as a combination of performance and cost. Value is increased by decreasing costs, while maintaining performance. Value is also increased by increasing performance, while maintaining cost, if the customer needs, wants, and is willing to pay for more performance. (Miles, 1989) SAVE International (2013) defines value as Function/Cost, where Value is the reliable performance of functions to meet customer needs at the lowest overall cost.

Value methodology (VM), a systematic and structured approach, improves projects, products, and processes. VM is used to analyze manufacturing products and processes, design and construction projects, and business and administrative processes. VM helps achieve balance between required functions, performance, quality, safety, and scope with the cost and other resources necessary to accomplish those requirements. The proper balance results in the maximum value for the project (SAVE International, 2013).

Objectives (Reasons for Adopting Program)

The primary objective was to show users “why so much unnecessary costs exists in everything we do and how to identify, clarify, and separate costs which bear no relationship to customers’ needs or desires” (Miles, 2013).

The objective of a Value Analysis (VA) or Value Engineering (VE) program is to reduce the cost of a product or service, either being produced by a company or purchased from another company. It is also directed at improving processes, facilities, systems and other areas of an organization.

A cornerstone of the value analysis approach is the purchasing function. As Lawrence Miles put it. “Purchasing must have a role in telling management about VA and must provide management with first-hand information on VAE methods and results. VAE methods must be used together to find an approach that combines direction, innovation, and knowledge, thereby allowing development of good products with reasonable profits” (Miles, 1983).

There is also a relationship between value analysis and target pricing and target costing. If a product's price is dictated by the marketplace, that price is an indication of the value placed on that product. Consequently, it falls on management to determine how to make the product for an acceptable cost, the target cost. Value analysis is a way to help focus on how best to achieve the target cost (Newman & McKellar, 1995).

History (Time Line, Reasons Originated, Principal Developers)

In 1947, Lawrence D. Miles created and introduced the concepts of value analysis and value engineering while working at General Electric (GE). This technique proved a valuable tool in product and process design at GE. It spread beyond GE throughout the world and has been successfully used by a variety of organizations (Wendt, 2013).

During the 1960s several government organizations began adopting the use of value management. Government mandated policies and laws have enforced strict guidelines that many of these agencies are required to follow. Public Law 104–106, enacted February 20, 1996, amended the Office of Federal Procurement Policy Act (411 U.S.C. 401 et seq.) by adding that each executive agency shall establish and maintain cost-effective value engineering (value management) procedures and processes (Alwerfalli & Schaaf, 2010).

In the early years, "Value Analysis" was the dominant term used to analyze the price that should be paid (the value) of purchased parts. Later, "Value Engineering" became more common and was applied to the analysis of product design. To combine the two ideas, the acronym VAVE was introduced. In recent years, "Value Management" has appeared, to suggest an even broader application of the technique. The progression is an indication of the enlarging scope of the practice, from individual product to process to enterprise to supply chain. Whatever the term used, it retains the basic idea of eliminating waste in all parts of an organization (Carbone, 1996).

An organization that actively promotes value analysis is SAVE International. It's philosophy is stated as follows: "In an age of increasing competition for financial resources, innovation and improved value are needed across all industries and levels of government. SAVE International® is the premier international society devoted to the advancement and promotion of the value methodology (also called value engineering, value analysis, or value management). Value methodology is used in government and the design, construction, and manufacturing industries to optimize projects, business and manufacturing processes, and product development. Bene-

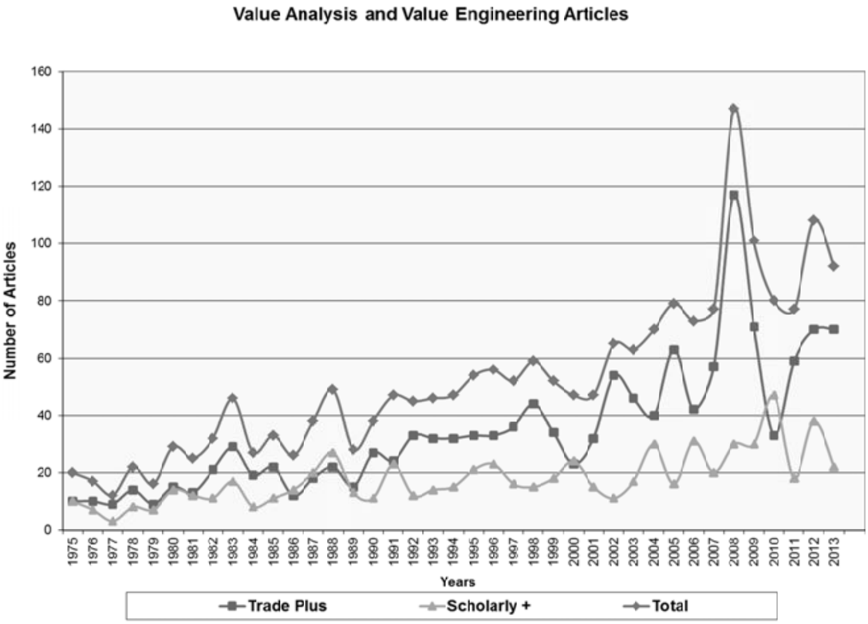

Figure 6E.1. Total number of Value Analysis articles.

fits include decreasing costs, increasing profits, improving quality and performance, and enhancing customer satisfaction" (SAVE International, 2013).

Figure 6E.1 shows the number of articles published about value analysis or value engineering. This program has been a topic of interest for over five decades, although it has morphed through several iterations from the original concept and name. The search engine we used reports articles as early as 1965 although the number of articles was light; however, the activity began to increase about 1990 and remains active at the present. Trade publications led in the early stages, but more scholarly journal articles have been written in recent years.

Expected Benefits (Tangible and Intangible)

The primary benefit of value analysis or value engineering is to reduce waste. This often is viewed as cost reduction; however, it could mean that products or processes are redesigned to increase value to the customer by improving quality, reliability or responsiveness. In addition to direct benefits, Value Engineering can promote creativity, innovation, and sustainability (Alwerfalli & Czarnik, 2010).

Some of the specific benefits proposed for value management include: (1) utilizing manpower efficiently at all organizational levels; (2) assuring that plant and equipment are used optimally; (3) using space effectively; (4) ensuring that technology is designed into operations rather than permitting it to be absorbed into an old system; (5) keeping financial systems up to date; and (6) reviewing manufacturing methods regularly (Speirs, 1985).

Although originally designed for manufacturing operations, value analysis techniques have found a wider range of applications. One of particular interest is healthcare. As reported by a leading healthcare journal, value analysis is a function-oriented, systematic team approach for providing, designing or investigating the right functions (primary, secondary and aesthetic) for the millions of dollars of products, services and technologies that are required to operate a healthcare organization. These studies focus on cost and quality improvements and the value methodology can be applied to any product, process, procedure, system or service in a healthcare organization (Anon, 2009).

In today's age of supply chains, some companies are finding the use of value analysis can improve the customer-supplier relationship. When suppliers are involved, they can provide ideas for improvement. This increases trust and strengthens the relationship (Hartley, 2000).

The value analysis technique can be combined with quality improvement programs, thereby building on the strengths of both programs. Some researchers propose that TQM can achieve its full potential by its integration with other performance improvement techniques. Value analysis, which focuses on product's junction and cost, is proposed as a potential area for cross-fertilization (Ho et al., 2000).

Another benefit is the integration of purchasing and management accounting interests. Both groups are interested in reducing costs. The value analysis approach can enhance make-or-buy decisions, and supplier selection, auditing and certification (Joyce, 2006).

Functional cost analysis is a cost management technique that helps managers to identify potential cost reductions. Derived from value analysis, functional cost analysis is proving useful in the public sector as well as the private sector (Kee & Walter, 2004).

Value analysis is also finding applications in the construction industry. Builders are finding ways to build equally strong functional structures using fewer materials. Use of the VAVE approach can integrate architects, contractors, owners and users in a project. (Martin, 1996) A more recent article advocates adding Lean techniques to VAVE to improve the design and construction of buildings (Sedam, 2010).

Value analysis can be important in product design. A product can be seen as a complex bundle of satisfactions that comprise a product package. Design affects all elements of the package. There is a great need to adopt formal procedures for dealing with complexity and uncertainty; also needed are multidisciplinary design teams. Design can be viewed as a coupling of the techniques of value engineering and value analysis with a shift of some of the responsibility for production into the design activity (Millman, 1986).

Barriers to Acceptance

Miles (1989) cautioned that implementation of a value analysis program must overcome a number of roadblocks, or "stoppers." He included such things as: the injection of generalities, the absence of meaningful cost information, the acceptance of answers from sources that are not the best, and the lack of ability to locate the necessary skills required.

The lack of available resources and the press for time are also barriers. In this age of short product life cycles, all businesses are racing to get new products to market quickly. Often, this means that design teams don't have time to search for the optimal design; they must "get it out" in time to meet an announced launch date.

Implementation Approach

A systematic and structural approach is recommended by SAVE International (2013). Their standard job plan consists of six phases:

1. **Information Phase**: Gather information to better understand the project.
2. **Function Analysis Phase**: Analyze the project to understand and clarify the required functions.
3. **Creative Phase**: Generate ideas on all the possible ways to accomplish the required functions.
4. **Evaluation Phase:** Synthesize ideas and concepts to select feasible ideas for development into specific value improvement.
5. **Development Phase**: Select and prepare the "best" alternative(s) for improving value.
6. **Presentation Phase**: Present the value recommendation to the project stakeholders.

The VM process produces the best results when applied by a multi-disciplined team with experience and expertise relative to the type of project to be studied.

Integrated cost reduction (ICR) is a technique that uses a collaborative approach to cost reduction that includes engineering, supply, design, marketing, and production all working simultaneously with partners/suppliers. It is designed to rapidly and systematically identify cost reduction opportunities in a product. The ICR process seamlessly integrates four proven and most widely used productivity tools: Six Sigma in quality; value analysis/value engineering (VA/VE) in design and purchasing; Lean manufacturing in production; and supply chain and e-procurement tools in procurement and logistics. The ICR process systematically uses a rapid seven-phase process and a set of software tools to ensure repeatability and consistent results (Nussle, 2006).

Value engineering is applied in the design stage and value analysis in the production or procurement stage, but the line between them is not always clear. Basic steps in applying VEVA are: (1) preparation; (2) problem selection; (3) information; (4) evaluation; (5) creation; (6) selection and presentation; and (7) implementation and follow-up. The active participation of suppliers should be sought because of their extensive product knowledge and ability to offer various types of assistance (Reuter, 1985).

Future

Several years ago, Mendelsohn and Greenfield (1995) felt that value analysis would morph into value management dynamics (VMD), a technique that builds on value analysis by including new developments in information technology and the growth of global economies. Founded in value engineering/value analysis, VMD is a methodology for converting design criteria and specifications for processes, products, projects or systems into function descriptions. The VMD approach requires multidisciplinary teams composed of an organization's own personnel, the customer, and outside experts (Mendelsohn & Greenfield, 1995).

Even after so long a run, Value Analysis or Value Engineering still remains a relevant program for companies looking for ways to reduce costs and achieve other benefits.

ACKNOWLEDGMENT

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CHAPTER 7A

STATISTICAL PROCESS CONTROL (SPC)

NAME AND BRIEF DEFINITION

Statistical Process Control (SPC)—The application of statistical techniques to monitor and adjust an operation. Often the term statistical process control is used interchangeably with statistical quality control, although statistical quality control includes acceptance sampling as well as statistical process control (Blackstone, 2013).

Statistical Quality Control (SQC)—The application of statistical techniques to control quality. Often the term statistical process control is used interchangeably with statistical quality control, although statistical quality control includes acceptance sampling as well as statistical process control (Blackstone, 2013).

Based on the above definitions, it is easy to see there is overlap between the terms statistical process control (SPC) and statistical quality control (SQC). While there may have been distinct differences in the earlier days of the quality movement, SPC has become the dominant program, at least in the minds of writers. Figure 7A.1 shows the total number of articles about SPC. For a management program, it has sustained a long period of popularity among writers.

The primary distinction between the two appears to be that SQC's focus is to assure the quality of the product and SPC's focus is to reduce the variability in the process that produces the product, thereby assuring a consistent quality of the final product. In theory, analysis of the product's

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 183–192
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quality (through SQC) level can lead investigators back to the cause of a quality problem, often the process of making the product. Conversely, SPC can improve the process and thereby improve the quality of the product.

Statistical process control (SPC) is a technique that is used to monitor, control, evaluate, and analyze a process, aiming continuously to improve quality, reliability, and service by reducing process variability. The full realization of SPC benefits can only be obtained with a full-scale plant-wide implementation. SPC must be part of an overall quality system developed in accordance with a clear vision of company objectives. Choosing the first process for SPC implementation is critical to the success of the project. Tools and equipment also need to be prepared and an appropriate measurement system established. The SPC system should be integrated with the overall quality information system. The SPC system needs to be maintained and allowed to grow and evolve until it becomes interwoven with the organizational culture (Gaafar, 1992).

Objectives (Reasons for Adopting Program)

There is a need to demonstrate to customers the product provided to them meets their quality expectations. Often, in the past, this was achieved by intensive efforts to inspect out the defective items and ship only the good items. While this approach may have worked, it is unlikely to be acceptable in the future because of its high costs and failure to assure a product with consistently high quality. Defective products usually are the result of assignable causes in the processes used to produce them. Consequently, the desired approach is to seek out the causes of the defects and eliminate them. That is the objective of tools such as SPC.

Regardless of the initial focus, both SQC and SPC advocate the rigorous use of analytical tools to identify causes of variations in the product or the process and, having identified the causes, take action to correct and improve the process, which, in turn, will improve the product.

The concept of tolerances was introduced by Shewhart, who recognized that perfect quality in interchangeable parts was unrealistic; however, it is possible to maintain close to perfect results in a process, thereby making acceptable quality a realistic possibility (Stauffer, 2003).

SPC is designed to prevent quality problems by eliminating their source. "SPC *uses* statistical analyses to monitor process performance in the hope of preventing quality problems, instead of finding them after the fact" (Mainstone, 1987).

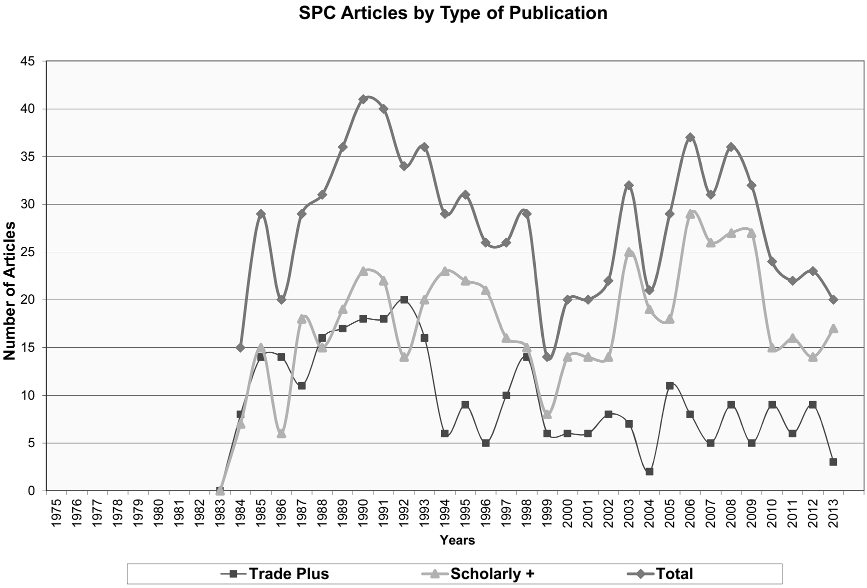

Figure 7A.1. Total Statistical Process Control (SPC) articles.

History (Time Line, Reasons Originated, Principal Developers)

Statistical quality control *(*SQC*)* started with Walter Shewhart's work at the Western Electric plant outside Chicago in the 1920s. Since then, *SQC* has evolved into *statistical* process *control* (SPC) to reflect the move away from product *control* to a systems focus (Gruska & Kymal, 2006).

Figure 7A.1 shows the number of articles written about SPC. The number of articles peaked during the early 1990s. Scholarly articles emerged as an area of interest of academics in the early 1990s and have continued to lead trade journals in total number.

Statistical quality control (SQC), renamed statistical process control (*SPC*), is one of several useful *process* analysis tools. Pareto and fishbone analyses can reveal where it is most advantageous to use SPC. Total quality control involves reorganizing for quality, setting customer-oriented goals, and instituting facilitating concepts. In batch-mix manufacturing and the continuous-flow industries, designing for quality translates into targets, such as design to target yield or design to target specifications. Taguchi methods bring cost back into the quality formula and suggests that users look at quality through performance, features, reliability, conformance, durability, serviceability, aesthetics, and perceived quality (Schoenberger, 1987).

SPC has been successfully used in a number of industries, including: Supermarket chains (Morgan & Dewhurst, 2007), Small organizations (Krumwiede & Sheu, 1996), Automotive suppliers (Krantz, 1989), Health care (Hutchison, 1994; Chetter, 2009a and b); Banks, hospitals, courier services and utilities (Herbert, Curry & Angel, 2003); and Marketing and finance organizations (Duarte, 1991).

Expected Benefits (Tangible and Intangible)

SPC is designed to control variability in the manufacturing or service transformation process, thereby improving the quality of the final product. Much of the power of SPC lies in the ability to examine a process and the sources of variation in that process, using tools that give weight to objective analysis over subjective opinions and allow the strength of each source to be determined numerically. Variations in the process that may affect the quality of the end product or service can be detected and corrected, thus reducing waste as well as the likelihood that problems will be passed on to the customer. With its emphasis on early detection and prevention of problems, SPC has a distinct advantage over other quality methods, such as inspection, that apply resources to detecting and correcting problems after they have occurred.

In addition to reducing waste, SPC can lead to a reduction in the time required to produce the product or service from end to end. This is partially due to a diminished likelihood that the final product will have to be reworked, but it can also result from using SPC data to identify bottlenecks, wait times, and other sources of delays within the process. Process cycle time reductions coupled with improvements in yield have made SPC a valuable tool from both a cost reduction and a customer satisfaction standpoint (Wikipedia 2010).

Getting a process under control can offer benefits other than just improved and consistent high quality products.

- A stable process means that resources previously committed to "fixing" quality problems can be reassigned to improving existing products or designing new ones. In pointing out how Japanese companies reported higher productivity than U.S. companies, Peter Drucker (1990) said, "The Japanese employ proportionately more machine operators in direct production work than Ford or GM. In fact, the introduction of SQC almost always increases the number of machine operators. But this increase is offset many times over by the sharp drop in the number of nonoperators: inspectors, above all, but also the people who do not *do* but *fix*, like repair crews and "fire fighters" of all kinds."

- SPC facilitates the introduction of JIT and lean manufacturing techniques. Connell, (1984) suggests the following steps to establishing JIT concepts with vendors: (1) Identify vendors willing to implement JIT and SPC: (2) Evaluate vendors' past performance; (3) Select vendors that are the closest geographically; (4) Establish a single vendor philosophy; (5) If necessary, pay vendors extra to implement SPC; (6) Evaluate quality requirements; and (7) Establish a cooperative relationship with vendors. JIT and SPC systems reduce vendors' selling and manufacturing costs and improve productivity through the prevention of errors.
- The supply chain will be more effective and efficient. On-time and complete orders will increase; transportation costs will decrease; excess inventories will decline; and supplier performance will improve because they will be better informed and face fewer disruptions.
- Employee morale will improve. They will recognize they are producing a better product and face fewer disruptions and complaints, either from customers or upper management.

Reduced process variability makes it easier and more effective to introduce other improvement programs such as lean manufacturing. It is also easier to effect changes to expand or improve supply chains, such as offshore outsourcing or the use of virtual organizations.

Barriers to Acceptance

The major barriers to a successful implementation of SPC include:

- Lack of acceptance by managers and employees
- Lack of training for managers and employees
- Failure to maintain discipline in the application of quality tools
- Difficulty in aligning program needs with resource capabilities

Lack of Internal Acceptance

The introduction of any new management initiative is usually met with resistance by both managers and employees. They have to do their work differently. Change represents a burden, because they now have to think about each step in the new process and relearn how to do a job they had previously done often without much direct thought. They also face the additional concern about the future of their employment. Will they be laid off after they help to reduce the labor content of their job? Or will they have to learn a new job, which they may not like as well as they did their old job?

A study of the implementation of statistical process control (SPC) in a U.S. automobile industry plant found cultural barriers to SPC innovation. The plant, located in the northeastern US, was built before World War II but generally used technology less than 10 years old. It was chosen because key personnel realized that implementing SPC also would require paying attention to social system dynamics. The plant had an established quality of work life program and was able to make six manufacturing supervisors full-time SPC coordinators. The experience showed three barriers to SPC: (1) learning versus performing; (2) the meaning of information; and (3) holism versus segmentalism. The first barrier arises because mass-production organizations value performance over learning. The second arises because SPC makes public information about problems. The third is a product of the segmentation of problems and information in most plants, while SPC treats the process as a whole (Bushe, 1988).

Statistical process control (SPC) is instrumental in institutionalizing a true quality culture. The following challenges to SPC introduction must be met:

- Earning employee confidence
- Overcoming the perception of being solely statistical tools
- Establishing clear rules for out-of-*control* conditions
- Training that involves management, and
- Creating the right implementation team for SPC.

Organizational problems may include scheduling and priority conflicts forcing workers to start without training or ineffective communication. In the 4-phase SPC Implementation Model, the first phase is organization, designed to secure the necessary commitment from managers. In the 2nd phase, the data collection and *process* capability study phase, the necessary context for SPC is established. In phase 3, the actual control scheme is designed. The control scheme is implemented in the fourth phase, which involves training and introduction throughout the organization (Jones, 1988).

Lack of Training

In one study of a number of companies, which were all actively using SPC, major training needs were found over the whole range of SPC-related activities. The companies that seemed most effective in the use of SPC had devolved more SPC procedures to employees lower in the organizational hierarchy. In those companies, all employees had good levels of education and the training tended to focus on domain-relevant and conceptually concrete approaches. In the other companies, diverse forms of training were used, with limited success (Cheng & Dawson, 1998).

Requires a Systematic Approach

SPC is not a program that can be approached casually. It requires an organized approach that includes data collection, analysis, action and evaluation or, in the jargon of Shewhart and Deming, a Plan-Do-Check-Act (PDCA) approach. SPC includes the use of several tools in identifying process variations, their causes, and establishing a priority in attempting to correct the causes. The tools of statistical process control (SPC), which has been used for decades to monitor and improve manufacturing processes, also can be used to help improve processes that are not directly related to the high-volume, repetitive manufacturing of goods. Seven basic tools that have an application outside of manufacturing are: the process flow diagram, the cause and effect diagram, the Pareto chart, the statistical control chart, the run or trend chart, the histogram, and the scatter diagram. An example of an inventory problem illustrates how the data methods can be combined with communication tools to get people involved in describing how a *process* works (flow diagram), what problems exist (fishbone diagram), and which problems have the most impact (Pareto chart) (Duarte, 1991).

Difficult to Align Program Needs With Resource Capabilities

Although SPC is, on the surface, an easy and straightforward technique, its implementation in an organization is a far more complex issue. Xie and Goh (1999) identified three main aspects of an SPC system: the management, the human and the operational aspect, which include all the issues that are crucial for the successful implementation of an SPC system in an industrial environment. Bird and Dale (1994) identified three key factors for the successful introduction of SPC; a capable measurement system, proper training and management commitment. The successful application of SPC requires a blend of management skills, engineering skills, statistical skills, communication and planning skills.

Implementation Approach

The steps in the implementation process can be summarized as Investigate, Identify, Control and Improve.

- **Investigate—**deciding where to begin the study. May include the use of Pareto analysis, wishbone diagrams and run charts to zero in on the most likely areas to study.
- **Identify—**isolating the assignable causes of quality problems and taking action to correct them. This is the heart of SPC and centers around the use of control charts to isolate assignable causes and initiate actions to correct or alleviate the problem areas.
- **Control**—solidifying the gains made in the Identify phase and establishing a reference quality level against which changes can be evaluated.
- **Improve**—taking action to reduce the common causes of variation to a new level, either by reducing the range of variation or reducing the level of defects.

Another SPC implementation approach is described as a series of activities that understanding the process, understanding the causes of variation, and elimination of the sources of special cause variation.

In understanding a process, the process is typically mapped out and the process is monitored using control charts. Control charts are used to identify variation that may be due to special causes, and to free the user from concern over variation due to common causes. By the nature of the control chart, understanding the process is a continuous activity. With a stable process that does not trigger any of the detection rules for a control chart, a process capability analysis is also performed to evaluate the ability of the current process to produce conforming (i.e. within specification) product.

When, through the control charts, variation that is due to special causes is identified, or the process capability is found lacking, additional effort is exerted to determine causes of that variance and eliminate it. The tools used include Ishikawa diagrams, designed experiments and Pareto charts. Designed experiments are critical to this phase of SPC, as they are the only means of objectively quantifying the relative importance of the many potential causes of variation.

Once the causes of variation have been quantified, effort is spent in eliminating those causes that are both statistically and practically significant (i.e., a cause that has only a small but statistically significant effect may not be considered cost-effective to fix; conversely, a cause that is not statistically significant cannot be considered practically significant). Generally, this includes development of standard work, error-proofing and training. Additional measures may be required, especially if there is a problem with process capability (Wikipedia, 2010).

SPC usually requires years of work and is a major cultural change. The first step in SPC is to look for possible causes of the defects. The second step is to prioritize the list. Concentration on the largest problem usually will point to the remedy. The heart of SPC is the control chart, which is a graphic representation of the variability in a process. Control chart information can aid in an almost instant correction of error or deviance (Rohan, 1989).

Factors important to effective implementation of SPC are: adequate control of the quality of materials entering the process, an accurate and stable measurement system, measurement of the process capability over a short period of time, design of a system for long-term process control, periodic auditing of control techniques, and establishment of methods to ensure continuous improvement (Coates, 1988).

Future

SPC continues to be a worthwhile quality improvement program for organizations that are willing to commit the resources needed and work through the steps in the process. It is not a quick fix; however, it does produce results.

Process improvement will be continued in combination with designing quality into new products through Quality Function Deployment (QFD). By putting more emphasis on designing products that have a lower potential for manufacturing and operating problems, the need for SPC will be lessened.

SPC will also be viewed as a way to improve product quality as part of a supply chain that moves the product from the design concept to a usable package for the consumer, in all steps of the supply chain, including product design, product development, manufacture, and distribution (including marketing, advertising, and other services)

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CHAPTER 7B

TOTAL QUALITY CONTROL (TQC)

NAME AND BRIEF DEFINITION

Total Quality Control (TQC)—The process of creating and producing the total composite good and service characteristics (by marketing, engineering, manufacturing, purchasing, etc.) through which the good and service will meet the expectations of customers (Blackstone, 2013).

Total quality control is an effective system for integrating the quality-development, quality-maintenance, and quality-improvement efforts of the various groups in an organization so as to enable marketing, engineering, production, and service at the most economical levels which allow for full customer satisfaction (Feigenbaum, 1991).

According to Kaoru Ishikawa, TQC pioneer, TQC embraces five strategic goals:

1. Quality must be sought before profits.
2. The infinite human potential of employees must be developed through education, training, delegation, and positive reinforcement.
3. A long-term consumer orientation must be fostered within and outside the organization.
4. Facts and statistical data must be used to communicate throughout the organization, and measurement must be used as motivation.
5. A companywide TQC/M system should be developed with the focus of all employees on quality implications of every decision and action (Rehder, 1984).

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 193–198
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TQC promotes the view that quality improvement is a companywide effort that focuses on making goods and services that satisfy the customers' "fitness for use" criteria. It is more of a concept than a methodology, although we will provide some steps to take in the implementation process.

Objectives (Reasons for Adopting Program)

Japan's concept of total quality control (TQC) puts the responsibility for quality squarely on the shoulders of the maker of each part. Company-wide quality control requires that quality improvement extend from top management to janitorial levels. TQC requires a long-term target and an operational plan. In Japan, shop people were made the central core of the quality control team and had to learn and exercise quality control techniques. The Japanese focus on preventing, not detecting, quality defects through: process control, insistence on compliance to high quality, visible, measurable quality, line-stop authority, self-correction of errors, and 100% quality checking. Supporting concepts to quality improvement involve producing in small lot sizes, exercising good housekeeping, and setting daily schedules at less than full capacity. Quality control circles and statistical and analytical aids are also used by the Japanese (Schonberger, 1982).

Feigenbaum (1991) stresses that the true meaning of quality is that the total composite product and service will meet the expectations of the customer. Expectations include the actual end use and the selling price of the product and service. In addition, there are additional product and service conditions to be met:

- Specification of dimensions and operating characteristics
- Life and reliability objectives
- Safety requirements
- Relevant standards
- Engineering, manufacturing, and quality costs
- Production conditions under which the article is manufactured
- Field installation and maintenance and service objectives
- Energy-utilization and material conservation factors
- Environmental and other "side" effects considerations
- Costs of customer operation and use, and product service

History (Time Line), Reasons Originated, Principal Developers)

A.V. Feigenbaum wrote *Quality Control* in 1951, which was reprinted as *Total Quality Control* in 1961. However, the concept was ahead of its time and confined primarily to a few companies for several years. Much of US industry now accepts quality as a fundamental business strategy to achieve both customer satisfaction and lower cost. However, in the early 1940s, quality was considered a technical field for a few specialists. The prevention-appraisal-failure concept of quality cost was introduced in 1956 along with a plan for *Total Quality Control (TQC)*. Consumer-purchases data in 1979 indicated that only 3–4 consumers out of 10 considered quality equal to or more important than price; in 1986, the proportion rose to 8 out of 10 buyers. TQC works because of a clear, customer-oriented management and work process throughout the organization.

Converting to a quality program calls for making global quality leadership a strategic company goal, establishing a systemic structure of quality management and technology, and setting up the continuing quality habit. A serious quality effort can result in greater customer satisfaction, higher sales volume, and improved profitability (Feigenbaum, 1987).

Figure 7B.1 shows that TQC reached its peak of popularity during the 1980s as a forerunner of the Total Quality Management (TQM) movement.

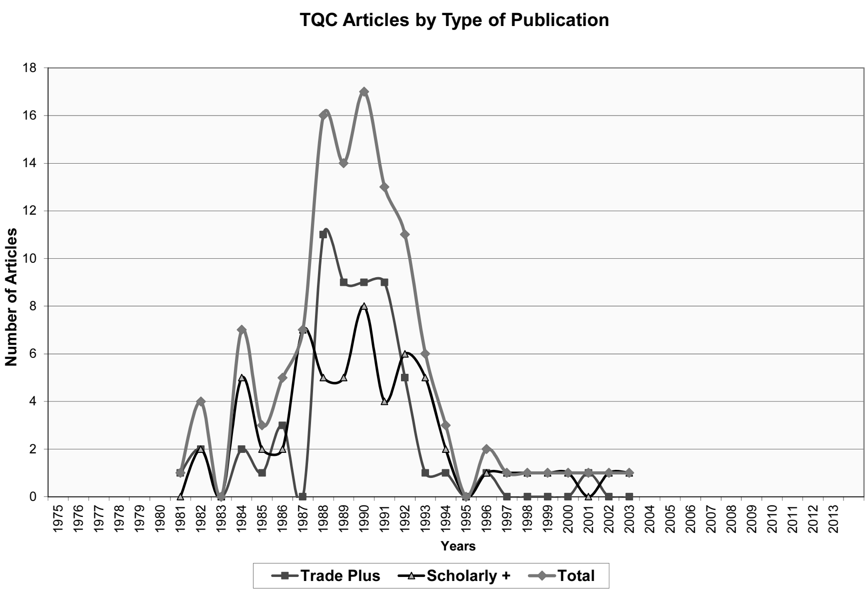

Figure 7B.1. Total number of Total Quality Control (TQC) articles.

Expected Benefits (Tangible and Intangible)

Marketing requirements often fail to reach the product designers. The prototype phase of the cycle is, however, too late to correct design mistakes. Total quality control (TQC) methodology can solve some design problems issues. Initially, process capabilities are investigated with the goal of continuous improvement of the production process. TQC helps the engineer understand and direct the product design through discussions involving employees at all levels. TQC requires motivated employees who rely on each other. Objectives of a TQC marketing program include:

1. Identifying and quantifying customers' needs,
2. Communicating functional design goals to product development teams,
3. Providing feedback, and
4. Supplying a cross-reference to manufacturing culture.

There are several methods to establish design benchmarks. Long- and short-term gains, including lower start-up costs, reduced tooling, and improved response to market shifts, can be realized from a TQC program (For a more thorough discussion of TQC benefits, see Hohner, 1989a, 1989b, 1989c).

Barriers to Acceptance

In recent years, many U.S. companies have adopted just in time (JIT), which requires a high level of quality control to be successful. Consequently, the separate concept of TQC has been sublimated within the JIT movement. In addition, the rise of Total Quality Management (TQM) as the latest quality program essentially replaced TQC.

Implementation Approach

Total commitment to quality is essential in order to realize benefits from a just-in-time (JIT) manufacturing program. A total quality control (TQC) program is a crucial step in implementing JIT. To ensure a successful manufacturing operation on the shop floor, TQC must begin at the product design phase. The achievement of a high-quality product design requires communication and integration between the marketing, engineering, and production departments. The fundamental theory and methodology of TQC provides a channel for presentation of marketing requirements to the engineering and production side of the manufacturing operation. In addition, TQC rejuvenates quality assurance throughout the organization and provides feedback and shop floor measurements that are available to the departments of manufacturing, engineering, marketing, and general management (Hohner, 1988).

Every process is an opportunity for quality, no matter what the process involves. To manage improvement, Hewlett-Packard (HP) implemented a structured process called Total Quality Control (TQC), with principles including focusing on the customer needs and expectations, standardizing to hold gains, and breaking down barriers between departments. While using this process, HP saw that TQC could be a valuable part of every process and that real process improvement avoids jumping straight to the solution. Understanding the current situation requires process flow charting and data collection. The process began with an organization-wide review of managers whose performance consistently rated them as exceptional. An analysis showed that the critical issue in effective planning was not sophisticated techniques, but creating ownership for the implementation. As a result, HP's Process of Management insights were incorporated with those emerging from the TQC process and with a formal annual planning process (Cobbe, 1993).

Future

TQC was largely incorporated into the TQM movement. As shown in Figure 7B.1, no articles have been written in the past decade specifically referring to TQC. TQC reached the end of its effective life cycle in the mid 1990s as TQM began its entry into the management program literature.

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CHAPTER 7C

TOTAL QUALITY MANAGEMENT (TQM)

NAME AND BRIEF DEFINITION

Total Quality Management (TQM)—A term coined to describe Japanese-style management approaches to quality improvement. Since then, total quality management (TQM) has taken on many meanings. Simply put, TQM is a management approach to long-term success through customer satisfaction. TQM is based on the participation of all members of an organization in improving processes, goods, services, and the culture in which they work. The methods for implementing this approach are found in teachings of such quality leaders as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, J. M. Juran, and Genichi Taguchi (Blackstone, 2013).

Motwani (2001) provides some general elements of a TQM program.

- **Total management commitment** is critical to building a culture centered on quality and TQM. Management can show support by allocating budgets and man hours for problem-solving meetings, being visible throughout projects, monitoring progress, and planning for change.
- **Quality measurement** techniques are central to identifying error-prone processes and tracking improvement over time. These include the Seven Tools of Quality: cause-and effect diagrams,

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 199–205
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check sheets, control charts, flowcharts, histograms, Pareto charts, and scatter charts.

- **Process management** includes anything that adds value to or removes deficiencies from a production process. Examples are reducing setup and cycle times, increasing production capacity, or reducing material handling. Process management is vital to a TQM program in that many of the actual quality improvements will be a result of process changes.
- **Product design** focuses on the customer and production feasibility. Representatives of multiple functional departments are included in the design process.
- **Employee training and empowerment** is necessary to make each member of a company feel like part of a team and to introduce them to the philosophy of continuous improvement, specific techniques used to apply TQM, and company goals.
- **Vendor quality management** is essential in avoiding "garbage in, garbage out" scenarios. Suppliers are evaluated and reduced in number as much as possible. Purchasing managers also become more visible to suppliers in an effort to increase inventory accuracy.
- **Customer involvement and satisfaction** is a principle objective of TQM and is assessed on a regular basis. Responding quickly to complaints and maintaining a company-wide goal to reduce such complaints are critical to an effective TQM program.

Objectives (Reasons for Adopting Program)

TQM found most of its popularity in manufacturing, but the program has also been successful in service industries, government, and even education. Essentially, this management program aims to increase revenue and market share by starting a chain reaction that begins with the customer. High quality goods and services that exceed expectations result in customer satisfaction and an improved public perception of a company and its products. This, in turn, theoretically leads to increased sales over time.

An effective program requires a company-wide commitment to quality and the continuous, incremental elimination of "deficiencies." Deficiencies are any part of the product or process that risk customer dissatisfaction (Dahlgaard, 1999). TQM may be appropriate for a company that wishes to increase product reliability or decrease the costs of defective merchandise. TQM is especially valuable in commodity markets where quality is more of a competing factor than price. Typical TQM programs stress the long term, guided by the idea that quality must be paramount in every executive, manager, and employees' work before the program can be effective.

History (Time Line, Reasons Originated, Principal Developers)

A.V. Feigenbaum wrote *Quality Control* in 1951, which was reprinted as *Total Quality Control* in 1961. The idea of Total Quality Control (TQC) was not immediately popular in the United States, but was a tremendous success in Japan, where it evolved into Company-Wide Quality Control (CWQC). CWQC is identical to what Americans know as TQM; TQC was the forerunner of TQM. The quality movement in Japan became a large part of the country's rebuilding economy and served to drastically change public perception of Japanese products.

By the early 1980s, many American companies were forced to look into quality issues as they struggled to compete with their Japanese counterparts. In 1986, President Ronald Reagan ordered that TQM be implemented in all agencies of the federal executive branch. The next year, the Malcom Baldrige National Quality Award was established by Congress to recognize companies that had successfully applied quality programs. Some of the first recipients were Motorola, Inc., Xerox Corp., and Westinghouse Electric. At this point, TQM was common practice in American business and government.

Figure 7C.1 shows the total number of articles written each year on TQM. TQM became popular about 1990 and the number of articles grew rapidly, peaking in 1993. Since then, the number of articles has settled into a slight decline, although there is still a great deal of interest among academics, as evidenced by the continuing number of articles from scholarly journals.

By the early 1990s, however, many companies had not yet seen their hoped-for increases in sales or market share and were questioning their investment in quality. TQM and the mantra of small, incremental change were trying the patience of American managers. Business Process Reengineering (BPR)—which brings about immediate results by overhauling an entire process or department—was becoming more and more appealing as a complement or outright replacement of TQM. Around the same time, Motorola and General Electric were receiving attention for their success with a program called Six Sigma—a spin-off from the statistical quality control methods employed in TQM. Applicants for the Baldrige award fell sharply after 1991, a sign that TQM had fallen out of vogue. However, attention to quality remained, and success stories continued to

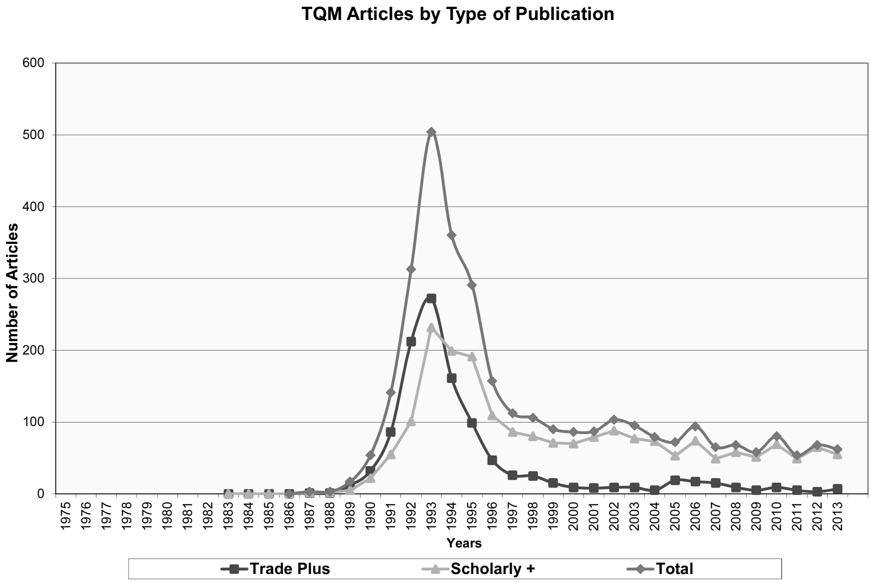

Figure 7C.1. Total number of TQM articles.

emerge. Many still believe that TQM, when appropriately applied, can significantly increase a company's ability to compete. However, Six Sigma has become the quality improvement program of choice during the past decade.

Expected Benefits (Tangible and Intangible)

Below are some of the benefits that businesses have realized after adopting a TQM program.

- Increased revenue
- Increased market share
- Better relations with suppliers, customers, and regulatory agencies
- Increased ability to get loans and credit
- Lower defect prevention and failure costs
- Updated processes
- Increased productivity
- Faster response time
- Higher employee satisfaction

Barriers to Acceptance

On the other hand, critics of TQM have argued the following points.

- Significant results are slow to come.
- TQM does not allow as much room for innovation and radical change as Business Process Reengineering (BPR) and other management programs.
- Costs and progress are difficult to quantify.
- There are diminishing returns on quality expenditures.

Many companies that have implemented total quality management (TQM) have found that they do not accomplish their stated goals because of three primary problems: 1. a lack of focus on the most critical business processes, 2. a failure to align the organization and its resources to support long-term improvement efforts, and 3. the separation of improvement from the strategic goals of the organization (Erickson, 1992).

Implementation Approach

Ninety percent of TQM is evaluation and planning, and the remainder is application. The excessive evaluation and planning period before a company adopts TQM is meant to ease the transition as well as break down any resistance to change within the company. Dahlgaard (1999) outlines four phases of implementation:

1. Self-evaluation involves answering four basic questions about the company:
   - Where are we now?
   - Where do we want to be?
   - How do we get there?
   - How will we measure our progress?
2. Educate management and employees about TQM, company goals, and methods of measuring progress.
3. Plan for a specific quality improvement, and involve managers and employees from multiple departments.
4. Apply the plan from (3). Analyze the improvement, measure progress, and go back to (3) for another improvement.

The cycle between steps (3) and (4) could go on indefinitely, with processes from all parts of the organization. Success is not without its obstacles, however. There are some common roadblocks: lack of trust throughout the organization, resistance to change, absence of total management commitment, short-run thinking, or even an outdated cost accounting system.

The largest resource used in implementing TQM is time. Time spent training, planning, and measuring progress adds up to a heavy investment, but it's one that's crucial to the TQM philosophy. Consultant fees are another significant cost. Some find that hiring a consultant is a good way to be guided through a transition to TQM, while others choose to look in-house. Like any investment, a quality program is financially accountable, and benefits like increased sales, market share, and employee morale are measured against time and funds put into the program.

Among large corporations, TQM was synonymous with Motorola, General Electric, Federal Express, and Westinghouse Electric. Small and medium-sized companies in a variety of industries have also had success with TQM, especially those that compete in international markets. Small businesses have an advantage in implementing TQM; transitions are easier with one or two locations and a small number of employees.

Future

While the quality movement had its genesis in the States, its growth and popularity came in Japan's post-war economy. There it was out of necessity rather than fashion that quality programs were adopted and improved upon for decades. By the 1980s, America found that its economy was being flooded with low-cost, high-quality merchandise from across the Pacific, and the tables of necessity were turned, so to speak. The lesson to be learned from this is that if TQM is implemented with a real need and a long-term commitment to its philosophy, the chances for success are good.

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CHAPTER 7D

SIX SIGMA

NAME AND BRIEF DEFINITION

Six Sigma Quality—The six sigma approach is a set of concepts and practices that key on reducing variability in processes and reducing deficiencies in the product. Important element is (1) producing only 3.4 defects for every one million opportunities or operations; (2) Process improvement initiatives striving for six sigma-level performance. Six sigma is a business process that permits organizations to improve bottom-line performance, creating and monitoring business activities to reduce waste and resource requirements while increasing customer satisfaction (Blackstone, 2013).

In practice, Six Sigma values hard data over personal experience and intuition. This is indicative of the program as a whole, as seen by its rigid structure. For each project there is a leader—a Six Sigma Black Belt or Master Black Belt who has gone through training and attained certification in Six Sigma techniques. The Black Belt is usually released from his or her daily activities to work on the project full-time. The project will have a Charter, a time line, a minimum annualized ROI, a planned conclusion date, and known deliverables. Most projects involve analyzing a specific process or system. The projects are driven by and focused on DMAIC (pronounced deh-MAY-ihk). DMAIC is a six sigma improvement process comprised of five stages:

- **D**etermine the nature of the problem,
- **M**easure existing performance and commence recording data and facts that offer information about the underlying causes of the problem.

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- **A**nalyze the information to determine the root cause of the problem,
- **I**mprove the system by effecting solutions to the problem,
- **C**ontrol the new process until the solutions become ingrained (Blackstone, 2013).

Usually, to jumpstart a new program, the first project selected will be one where change is guaranteed to bring high returns. Another way that Six Sigma plants the seeds of companywide change is through the use of a common vocabulary. (American Banker, 2002) A few Six Sigma terms are listed below:

- **Black Belt**: Team leaders responsible for steering improvement projects. Black Belts usually have at least four weeks of training in Six Sigma methods, and work on projects full-time. They are generally selected for their leadership and communication skills.
- **Green Belt**: Members of improvement project teams, working under Black Belts. Green Belts have a working knowledge of Six Sigma and some training of its methods, specific to their area of responsibility.
- **Leadership Council**: Senior executives responsible for defining the company's Six Sigma initiatives and determining how compensation will be tied to project successes.
- **Theory of Constraints**: A decision-making process originally described by Eliyahu Goldratt in his book, *The Goal* (North River Press, 1992).
- **Champion**: Senior managers who oversee projects. Champions ensure resources and break down potential barriers to project success (Ellis, 2001).

Objectives (Reasons for Adopting Program)

Companies that implement a Six Sigma quality program are ones who believe they can cut costs, improve customer service, and produce consistently high-quality products by analyzing and improving business processes. Six Sigma advocates believe that people don't cause defects, systems do, and that even human error can be minimized by an effectively designed process (Biolos, 2002). The term Six Sigma represents statistical perfection, or about 3.4 defects per million. Most manufacturers operate at three sigma, or 66,000 defective parts per million.

A Six Sigma program aims to significantly reduce product variability by critically analyzing a process with hard data gleaned from carefully designed experiments. That data, rather than brainstorming or quality circles, is used to identify the root problems causing the defects. Consistent products lead to decreased quality costs: those associated with scrap, rework, and foregone revenue stemming from dissatisfied customers. As with most management methodologies of the late twentieth century, customer satisfaction, total management commitment, and a quality-focused culture are all critical to a Six Sigma program's success. To actually achieve Six Sigma limits on a control chart is an impossibility in most cases, but advocates insist that a mindset bent on the pursuit of perfection is more important than reaching it (Connolly, 2004; Ellis, 2001).

Six Sigma is quickly associated with Motorola, where the program originated. GE, AlliedSignal (now Honeywell), Dow Chemical, and DuPont have also been major adopters of the program. Service industries as varied as healthcare, distribution, logistics, and banking have also reported success from their own Six Sigma tactics. As the program's popularity grew, so did the number of consultancies versed in its methods; this diversified the market for Six Sigma training to include small and medium-sized businesses. Six Sigma is best suited for an organization with one or more very repetitive processes, including document-intensive administrative functions.

History (Time Line, Reasons Originated, Principal Developers)

In 1985, Motorola's Bill Smith presented a paper noting that products assembled without error rarely failed in early use by the customer. This developed into the concept of Six Sigma, a way to standardize how defects are counted. Another Motorola employee, Mikel Harry modified Smith's principles and started his own consultancy, Six Sigma Academy. Six Sigma was not revolutionary; there was very little about the program that hadn't been done in previous quality and statistical control initiatives. Six Sigma is essentially a combination of several successful techniques. That familiarity along with active marketing, packaging, and endorsement by consultants and the American Society for Quality contributed to Six Sigma's continued growth and popularity (Dalgleish, 2003; Halliday, 2001).

Figure 7D.1 shows the number of articles published about Six Sigma. From a slow start in the late 1980s and early 1990s, the number of articles increased rapidly, reaching a peak in the 2006-2008 time period. As usually happens, articles from trade magazines dominated early but, in

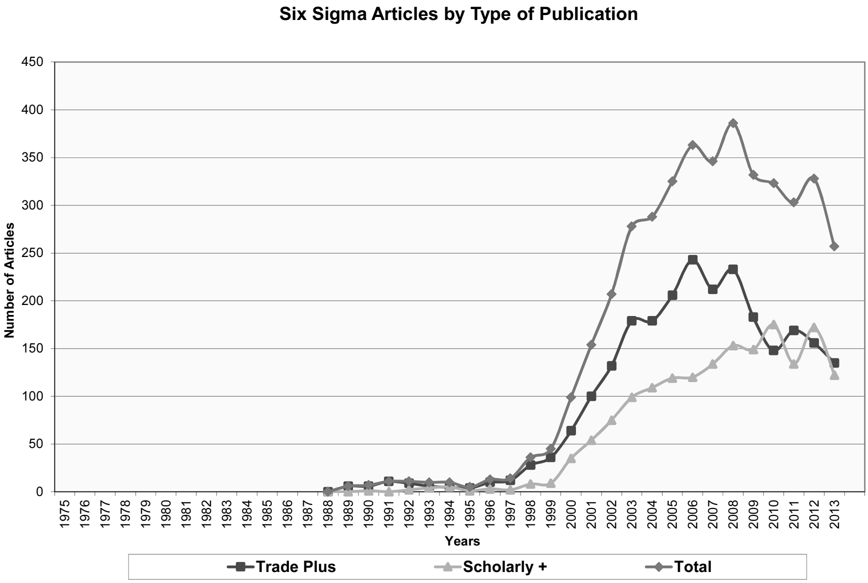

Figure 7D.1. Total number of Six Sigma articles.

recent years, the articles are equally divided between trade magazines and scholarly journals.

Expected Benefits (Tangible and Intangible)

The list of benefits associated and touted with Six Sigma is long and well publicized. They can be summarized and grouped by beneficiary: the customer, the bottom line, and the company itself.

The first beneficiary of a successful Six Sigma program should be the customer. The customer will ideally see a product that meets and exceeds his or her expectations for it, and will file the experience in memory where it will wait until the next purchase.

The most celebrated benefits of Six Sigma are the effects on the financial statements. Revenues can increase due to a combination of better productivity and customer satisfaction. Costs can be deeply cut, proving that quality costs are not only real, but very material.

Finally, the company as a whole may benefit from a new commitment to learning and improvement. Also, Six Sigma has proved to be an effective framework for other management strategies like Lean Manufacturing.

Barriers to Acceptance

Six Sigma's harshest critics argue that the program is just another trend, and that employees are tired of this year's solution. This particular trend has been especially commercialized as evidenced by the number of consultants offering training and the legal battles waged over Six Sigma vocabulary (Dalgleish, 2003). The term Six Sigma itself is a registered trademark of Motorola. The flurry of praise that surrounds such a trend often clouds its actual significance. For example, Motorola claims their Six Sigma program saved the company $16 billion dollars between the late 1980s and the turn of the millennium. Yet one must realize that a company of Motorola's size makes twice that in revenues almost every year. $16 billion does not seem as astounding when considering the entire picture. Smaller businesses don't operate at near the volume to experience that amount of savings, or even that proportion of savings (Ellis, 2001).

Another complaint is the reliance on standardization. Long ago, Henry Ford proved that standardization can cut costs and increase efficiency. Usually, a Six Sigma process improvement involves standardizing of some part or all of the process. Of course, highly customized processes won't react well to this. A question many companies find themselves asking is this: Where on the continuum of processes from repetitive to customized does Six Sigma become appropriate? A wrong answer can result in wasted time and effort trying to revitalize a process that should have been left alone or examined with a less quantitative approach (Biolos, 2002).

Implementation Approach

Adopting an official Six Sigma program usually involves outside training. Executives are trained in the basic theories and versed in the responsibilities as a member of the leadership council. Other individuals (the number of which may vary, depending on the size of the firm and the scope of implementation) are trained and certified as Black or Green Belts. Also, as part of change management, any other party that will be involved in or affected by projects may also go through a basic level of training or take part in a few meetings to facilitate the transition. There are as many different training programs as the number of consultancies offering them. Most award certification after four weeks of training, spread over four months.

As noted above, there is nothing radically new about Six Sigma, and therefore formal training is not totally pertinent to a successful implementation. Six Sigma is a blend of several statistical control techniques with a customer-service and process design orientation, and a similar program can probably be developed in-house or with the aid of a peer group.

Processes are generally selected for improvement based on their degree of repetitiveness. More repetitive processes are better suited for testing and later, standardization. Repetition does not necessarily have to apply to the product itself. Job shops and contractors have benefited from Six Sigma techniques by using them to gain control over administrative functions like bidding and invoicing.

As with almost any change in management philosophy, a company-wide commitment to the long-term is the most vital piece of implementation. From top management, this can be shown by tying incentives to project success (Biolos, 2002; Halliday, 2001).

From 1999 to 2002, the number of Six Sigma projects underway or concluded at DuPont grew from about 1,100 to more than 10,000, and were delivering about $800 million in pretax benefits. The company also introduced Design for Six Sigma (DFSS) into its R&D operations to reduce cycle time and optimize R&D project effectiveness (Connolly 2003).

Carmet Company, which makes cutting tools, paired Six Sigma with statistical software from Minitab and brought yield from 88% to 98.5% in three weeks. The software was critical to processing the data quickly so that the process change could be made (Schmidt, 2000).

Bank of America adopted Six Sigma in an attempt to dramatically improve customer satisfaction. Their goal is for 92% of customer response cards to say that the customer was "highly satisfied," versus 42% in 2002. To accomplish this, they've hired 100 Six Sigma and quality veterans; they've also created a new executive position, Head of Quality and Productivity (American Banker, 2002).

Estimates for Black Belt training vary from $7,800 to $20,000 or more per person. (http://www.qi-a.com) With additional training opportunities for Green Belts, Yellow Belts, executives, and continuing education, a Six Sigma program can be just about as expensive as one can imagine. However, in the time since Motorola introduced Motorola University and Mikel Harry came out with Six Sigma Academy, the program's popularity has grown tremendously, as have the number of consultants and MBAs willing to offer their Six Sigma services. Experts in the field are sometimes valuable resources since a poorly applied program can be an annoyance at best and a tragedy at worst. Several books are devoted to Six Sigma, many of which go into great detail about the program and the statistical methods applied. Below is a short list of some of the websites and books where one can find more information:

- American Society for Quality (www.asq.org/)
- ASQ Six Sigma Forum (www.sixsigmaforum.com)

- The Six Sigma Way: How GE, Motorola, and Other Top Companies are Honing Their Performance (Pande, Neuman, & Cavanaugh, 2000).

Future

Many other popular management initiatives were developed as early the 1960s, as where the principles that make up Six Sigma. Yet Six Sigma in its current form was born in 1985—in the midst of the marketing age. This probably explains its impressive packaging and the exhaustive Six Sigma advertising that companies have been exposed to over the last decade. Nonetheless, Six Sigma is composed of time-tested quality, statistical, and design tools that have served many companies since long before the Six Sigma program was introduced.

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CHAPTER 7E

QUALITY FUNCTION DEPLOYMENT (QFD)

NAME AND BRIEF DEFINITION

Quality Function Deployment (QFD)—A methodology designed to ensure that all the major requirements of the customer are identified and subsequently met or exceeded through the resulting product design process and the design and operation of the supporting production management system. QFD can be viewed as a set of communication and translation tools. QFD tries to eliminate the gap between what the customer wants in a new product and what the product is capable of delivering. QFD often leads to a clear identification of the major requirements of the customers. These expectations are referred to as the voice of the customer (VOC). See: house of quality (Blackstone, 2013).

In most quality initiatives of the twentieth and twenty-first centuries, the central philosophy has been the elimination of "negative quality" like defects or imperfections that do not add value to the customer. Quality Function Deployment, however, takes a different approach. QFD aims to add "positive quality" to a new product by going beyond customer expectations (Mazur, 2003).

In a traditional new product development process, specifications pass from department to department, and often the customers' voice supplied by marketing or sales is lost or misinterpreted by the time the product gets to manufacturing. QFD is a cross-functional initiative, where all departments are involved in product development. This team translates

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literal customer concerns into detailed product specifications, and builds exceptional quality into the product *before* manufacture.

The QFD approach stresses the need to use the "voice of the customer" in designing new products. To do this successfully in most companies, the marketing function must be involved. Consequently, QFD is a way in which the marketing and operations functions learn to work together.

History (Time Line, Reasons Originated, Principal Developers)

Professor Shigeru Mizuno and Yoji Akao in Japan developed QFD in the 1960s; its principles were later merged with value engineering, introduced to Japan by Katsuyoshi Ishihara. In the Post-WWII era, Japanese companies developed several customer-centric management philosophies. QFD was part of this trend, which included just-in-time inventories (JIT), and total quality control, which later morphed into Total Quality Management (TQM). The first applications of the QFD concept were in the mid 1960s, and reached fruition with the introduction of the quality chart in 1972 in the Kobe shipyards of Mitsubishi Heavy Industry. QFD was formally introduced to the United States in 1983 when the American Society for Quality Control published some of Akao's work in *Quality Progress* (Akao & Mazur, 2003).

In their 2003 article, Akao and Mazur provide a number of interesting facts about the early days of QFD, including the origin of the name from Japanese words that eventually become quality function deployment. The evolution of QFD can be divided into ten-year periods. In the first ten years, most QFD projects were internal, meant to clarify quality specifications to different departments. The second ten years saw QFD projects include customer requirements that were carefully analyzed before development. In the third decade of QFD, customer expectations were part of product development from the very first step: conceptualization. By the turn of the millennium, some QFD projects incorporated the entire forward supply chain, down to the end customer.

Figure 7E.1 shows the number of articles published about QFD. Of the articles written, over 85% of them have been in scholarly journals. This is in marked contrast to most management programs, especially those with three-letter acronyms, where articles in scholarly journals lag those in trade publications. Researchers have studied QFD in a variety of settings, both manufacturing and service. Many of the articles are case studies. Authors have also compared it with other product design methodologies and its use in conjunction with these models. While it has been of great interest to scholars, it has not had the same attraction for practitioners, as

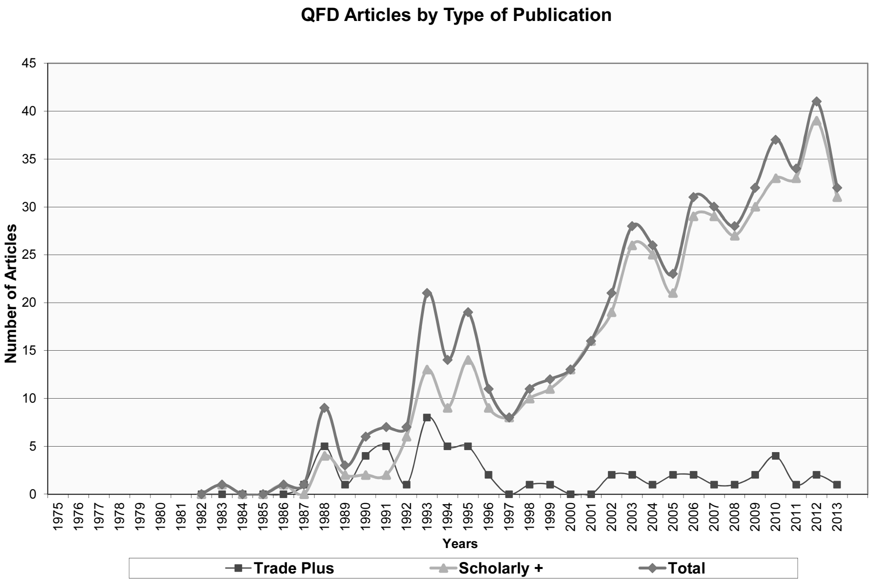

Figure 7E.1. Number of QFD articles by year.

only one or two articles per year have been written about QFD in practitioner journals over the past 15 years. The attraction for study is of global interest, with articles provided by scholars throughout the world.

Description of the QFD Process

Quality Function Deployment (QFD) is a methodology designed to ensure that all the major requirements of the customer are identified and subsequently met or exceeded through the resulting product design process and the design and operation of the supporting production management system. QFD can be viewed as a set of communication and translation tools. QFD tries to eliminate the gap between what the customer wants in a new product and what the product is capable of delivering. QFD often leads to a clear identification of the major requirements of the customers. These expectations are referred to as the voice of the customer (VOC). See: house of quality (Blackstone, 2013).

The focal point of the QFD process is a matrix called the "house of quality, (HOQ)." The APICS Dictionary (2008) describes the HOQ as a structured process that relates customer-defined attributes to the product's technical features needed to support and generate these attributes. This technique achieves this mapping by means of a six-step process:

1. Identify customer requirements. This describes WHAT is to be done.
2. Identify supporting technical features to satisfy the requirements. This describes HOW it can be done.
3. Correlate the customer requirements with the supporting technical features. This describes how well the HOWs satisfy the WHATs.
4. Identify the relationship among the technical features. This describes how well the HOWs interact.
5. Assign priorities to the customer requirements and technical features. This describes which of the HOWs to evaluate first.
6. Evaluate competitive stances and competitive products. This describes how competing products are satisfying the customer WHATs.
7. Determine which technical requirements to deploy in the product design. This describes the HOWs to be included in the final product.

When completed, it has the appearance of an unfolded house, as shown in Figure 7E.2. For a more complete explanation of each step, see Evans and Lindsay (1999), Hauser (1988), or Prasad (1998).

The House of Quality, shown in Figure 7E.2, is the most important part of the QFD process, and many companies stop after completing this step. However, the QFD concept includes three additional houses that extend the product design in the first house to consider the detailed requirements of subsystems and components. Often, the first two houses are primarily the responsibility of product development and engineering

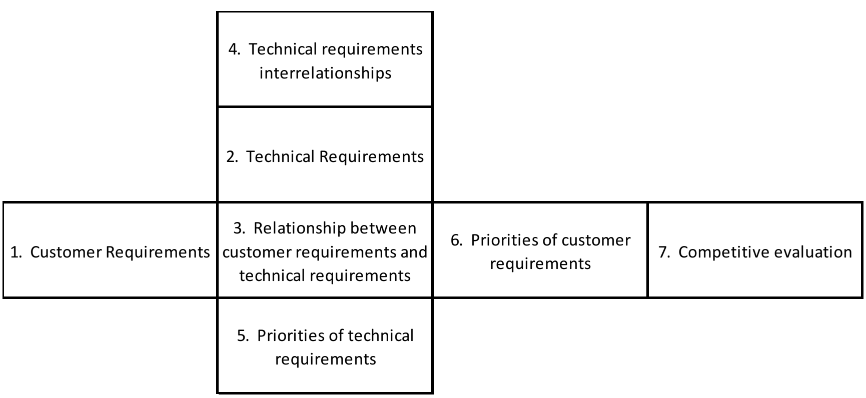

Figure 7E.2. The House of Quality.

functions. In the third house, process requirements are planned, and, in the fourth house, production planning requirements are included (Ansari, 1994). When complete, the QFD process links the new product design with the subsequent production process. Prasad (1998) describes an extension of the house of quality he labels the extended house of quality (EHOQ) and suggests a more elaborate three-dimensional configuration called the house of value (HOV).

Expected Benefits

When properly used, QFD can provide a number of benefits, including: reducing initial quality problems, reducing design changes, cutting development time, reducing development costs, communicating quality-related information to later processes, analyzing and accumulating market quality information, designing new products that have a competitive advantage, and expanding market share (Akao, 2003).

In the traditional product planning process, new products were developed by design teams or research and development teams who relied often on extending in-house knowledge and skills from existing products into evolutionary new products. As a result, a good deal of time was often spent in redesigning products and production systems to satisfactorily meet customer needs. QFD attempts to eliminate this waste by more closely designing products that meet customer needs directly (Evans & Lindsay, 1999).

Traditional product design methods rely on drawn-out market testing and multiple rollouts; these take too much time in a fast-moving economy. QFD can eliminate the need for such testing by understanding what the market wants *before* design and then ensuring that those characteristics are included in the final product.

As described earlier, another major benefit is linking new product design with production planning. This also eliminates wasted effort in redoing designs that are difficult, impractical, or impossible to produce. Panizzolo (2008) describes the use of QFD to identify a variety of services that manufacturing firms can add to their product to improve customer service for pre-sale, during-the-sale, and after-sale phases.

Barriers to Acceptance

QFD attempts have failed or yielded sub-optimal results for three main reasons. First, company cultures of individuality, impatience, and determination were not receptive to QFD values like teamwork, communication, patience, and systematic procedure. Second, QFD was mistaken as a quality tool, thus ignoring functions like marketing, sales, and purchasing which should have been vital to garnering and delivering customer expectations. Finally, a complaint often voiced is that QFD is a very time consuming process and tends to be demanding in quantifications of abstract ideas. Ranking customer expectations against each other and correlating those rankings to a final design can be too subjective for some managers to have confidence in a new product.

One barrier that appears early in the QFD process is determining what the customer wants. Many indirect approaches to obtaining this information are offered; however, Mazur is adamant in his declaration that it is necessary to gather information through direct observations of customers. "Unlike other customer information gathering techniques, such as focus groups and surveys, we do not ask questions about problems with our technology or marketing, we do not remove customers to an artificial site, and we do not rely on customers' memories to report problems to us. Rather, we employ all of our senses using contextual inquiry, videotaping, audio taping, direct observation, direct interviewing with customer's employees, etc. for the larger purpose of trying to understand how we can help our customers better conduct their business with their customers" (Mazur, 2003).

Implementation Approach

QFD has been applied across the spectrum of industries. An incomplete list includes manufacturing, aerospace, software, communications, IT, chemical, pharmaceutical, defense, government, research and development, and multiple service industries. Some of the more prominent companies with past or present QFD programs are 3M, AT&T, Boeing, Chevron, DaimlerChrysler, EDS, Ford, General Motors, Gillette, Hewlett-Packard, Hughes, IBM, Jet Propulsion Lab, Kawasaki Heavy Industry, Kodak, Lockheed-Martin, Marriott, Motorola, NASA, NATO, NEC, Nissan Motors, Nokia, Pratt & Whitney, Proctor & Gamble, Raytheon, Sun Microsystems, Texas Instruments, Toshiba, U. S. Department of Defense, Visteon, Volvo, Xerox, and many others (Mazur, 2003).

QFD initiatives may begin with training and certification (like Six Sigma, there are Belts involved.), but the concepts are relatively simple. New product development—or existing product improvement—with QFD principles typically follows four phases:

- Customer requirements are translated into design specifications
- Design specifications are translated into individual part details

- Process descriptions are derived from parts required
- Finally, production requirements for the processes are determined

The main idea is to preserve the voice of the customer throughout the design process, and to build quality into the product *before* production.

As noted above, QFD is distinct from other quality initiatives in that it focuses on "positive quality" and literal translations of customer expectations. A typical QFD program involves carefully analyzing customer expectations and documenting them in a "voice of the customer table" (VOCT). These expectations can be divided into three groups from Kano's Model of Customer Requirements, as described by Mazur, (2003):

Normal Requirements: These expectations yield satisfaction or dissatisfaction in proportion to their presence or absence. Examples would be fast delivery or courteous service. Normal requirements are those that customers use to compare vendors.

Expected Requirements: These are basic services without which the product would lose value. Often, satisfaction is not expressed for these services, but dissatisfaction is dramatic when they are absent. The temperature of coffee is an example. Hot coffee does not elicit overwhelming gratitude, but cold coffee is instantly returned. Quality initiatives like TQM work to improve customer satisfaction only by removing defects from normal requirements and expected requirements.

Exciting Requirements: These are difficult to discover. Exciting requirements are not expected or normal, but they elicit high customer satisfaction when present. For example, grocery discount cards were exciting requirements when first introduced. After they became commonplace, they were normal requirements. Expected requirements can become exciting requirements if their prolonged absence created trauma—like power being restored after a hurricane.

After these requirements are identified, they are translated into increasingly detailed descriptions with the aid of a series of matrices. The first matrix may be word-for-word customer requirements matched against relevant engineering characteristics. The next logical matrix would be those same engineering characteristics matched against the parts they require. Then, parts would be in a matrix with processes required, and finally, processes would be matched against production requirements.

MD Robotics of Canada used QFD to design three lifelike dinosaurs for Universal Studios in Florida. Their customer requirement—that of Universal Studios and visitors to the theme park—was that the dinosaurs be the most realistic robotic animals they had ever seen (Bolt, 1999).

Toyota Auto Body, one of the first organizations to contribute to the popularity of QFD, reduced their new vehicle startup and preproduction costs by 61% from 1977 to 1984. DuPont used QFD to serve internal customers. A department that designs processing equipment for the chemical and textile product groups reduced design time from twelve months to three, and the equipment met all of the necessary requirements the first time out. Training and QFD certification is available through organizations like the QFD Institute (www.qfdi.org); business consultants also offer services related to QFD.

In addition, the founders of QFD have published English versions of their writings. Shigeru Mizuno and Yoji Akao's *Quality Function Deployment: The Customer-Driven Approach to Quality Planning and Deployment* (1994) and Akao's Quality Function Deployment: Integrating Customer Requirements into Product Design were two of the earliest books about QFD. Glenn Mazur has also been closely involved with the integration of QFD in the United States and has written extensively about some of the applications at www.mazur.net/mazur_presentations.

Future

Integrating QFD into product development can be a lengthy process because it combines qualitative and quantitative elements in a challenging way, but the principles behind the philosophy are solid. When functional departments do not openly communicate during product development, misinterpretation of design components critical to customer satisfaction is inevitable. The cross-functional design team addresses this problem, and the series of matrices effectively organize the translations from value-adding expectations to production.

A natural alliance of management programs would be aligning Customer Relationship Management (CRM) with QFD. CRM is a program that enables businesses to establish a closer and lasting relationship with their customers, a necessary arrangement if they are to truly understand what their customers need and want.

A number of companies, in a variety of industries, have used QFD successfully, if the case studies are an indication of its application. However, the applications are spotty and QFD does not appear to have reached a level of critical mass, or a tipping point, to transform it from the early stages of an innovative methodology into a widely used technique. While it offers opportunities to reduce indirect costs, it does not have the intensity of focus to reduce direct costs, such as with lean manufacturing or Six Sigma. When other programs, such as Product Lifecycle Management (PLM) or the Cradle-to-Cradle concept in the sustainability literature, become more popular, QFD may become recognized as a key to achieving longer-range, and strategic, objectives.

Until then, QFD is a valuable product development tool that applies wherever there are customers with expectations and producers who are willing to invest the time and resources to design and develop products that effectively meet those expectations.

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This description of QFD is taken from Crandall, R. E. (2010). House Plans, Quality function deployment helps design a better product, *APICS Magazine, 20*(4), 28–31.

CHAPTER 8A

ACTIVITY-BASED COSTING (ABC)

NAME AND BRIEF DEFINITION

Activity-based Cost Accounting (ABC)—A cost accounting system that accumulates costs based on activities performed and then uses cost drivers to allocate these costs to products of other bases, such as customers, markets, or projects. It is an attempt to allocate overhead costs on a more realistic basis that direct labor or machine hours. Syn: activity-based costing. See: absorption costing (Blackstone, 2013).

Some of the other accounting programs most closely related to ABC include:

1. **Abandoning Management Accounting**—Some companies reason that, if traditional cost and management accounting methods are misleading and too passive in times of rapid change, they can use nonfinancial measures to control and improve their businesses.
2. **Process Costing**—Changes in manufacturing are moving companies away from batch processing to flow processing. With smoother and rapid flow of materials through the manufacturing process, it is not necessary to use job shop costing.
3. **Direct Costing**—To determine product costs, direct costing includes only those costs that can be directly assigned to the product. Indirect/overhead costs are analyzed separately but are consid-

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ered period costs and not included in inventory valuation. Direct costing is strictly a management accounting tool; it is not acceptable for financial accounting.

4. **Actual Costs**—With the rapid changes in products and processes, standard costs have lost their usefulness because it is too cumbersome to change standard costs during accounting periods. Reporting actual costs, especially against goals or targets, is more useful.
5. **Throughput Accounting**—Even more restrictive than direct costing in assigning costs to products (includes only materials). Primary focus is to optimize the flow of materials through the plant; develops a cost per critical resource hour.
6. **Life-Cycle Costing**—With shortened product life cycles, management accounting must include beginning-of-life costs (R & D) and end-of-life costs (conversion or liquidation) in the expected product cost during its effective life.
7. **Japanese accounting methods**—Japanese accounting is more dynamic by focusing on target costs instead of standard costs. Japanese management accountants participate in the continuous improvement planning and use simpler, nonfinancial measures to monitor progress.

An ABC system assigns costs to products based on the product's use of activities. Traditional costing systems have assigned costs based largely on product volume. ABC systems assign costs on the belief that the use of activities determines the costs incurred. ABC systems are sometimes called transaction-based accounting or value-added costing; however, all have the common premise that changes in activity level "drive" costs.

In order to obtain the cost information needed for ABC, accounts separate from those used in financial accounting, will be needed. ABC does not interfere with the accounts needed for external reporting; however, the ABC system is most effective when integrated into the financial accounting system. This integration precludes discrepancies in the total costs and makes it easier to coordinate decisions involving both operations requirements and financial requirements.

Figure 8A.1 shows the traditional way of allocating overhead costs. All of the overhead cost categories are combined into a single overhead cost pool, regardless of the differences in types of costs. The total overhead costs for a given time period, usually a year, are then assigned an overhead rate by dividing the total costs by an allocation base, such as total direct labor hours, or direct labor dollars, required for the same time period. As the products are produced, they "absorb" overhead based on the number of direct labor hours required for making a product.

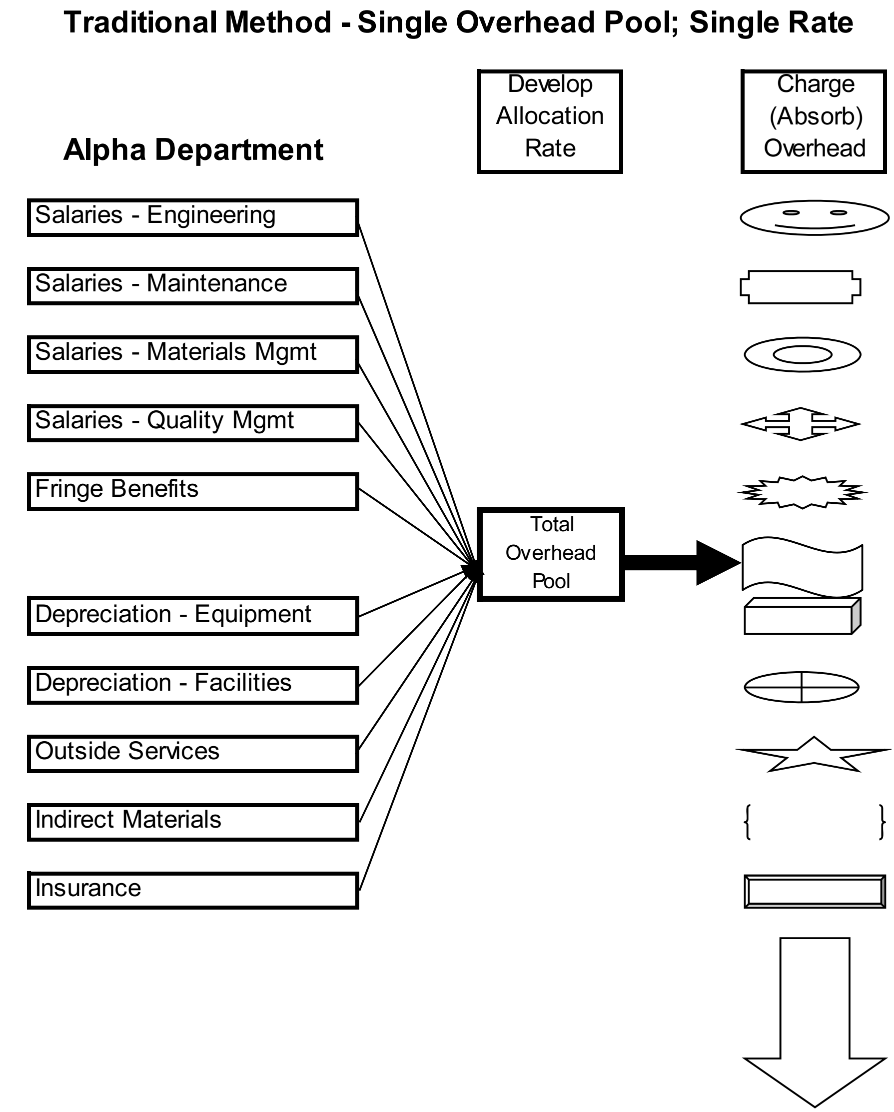

Figure 8A.1. Traditional method of allocating overhead.

Figure 8A.2 shows the ABC method of allocating overhead costs. Each overhead cost category is assigned a cost driver, such as engineering change orders (ECO) for engineering salaries. The total engineering salaries for the time period (such as a year) are divided by the number of ECOs expected for the same time period. As the products are produced,

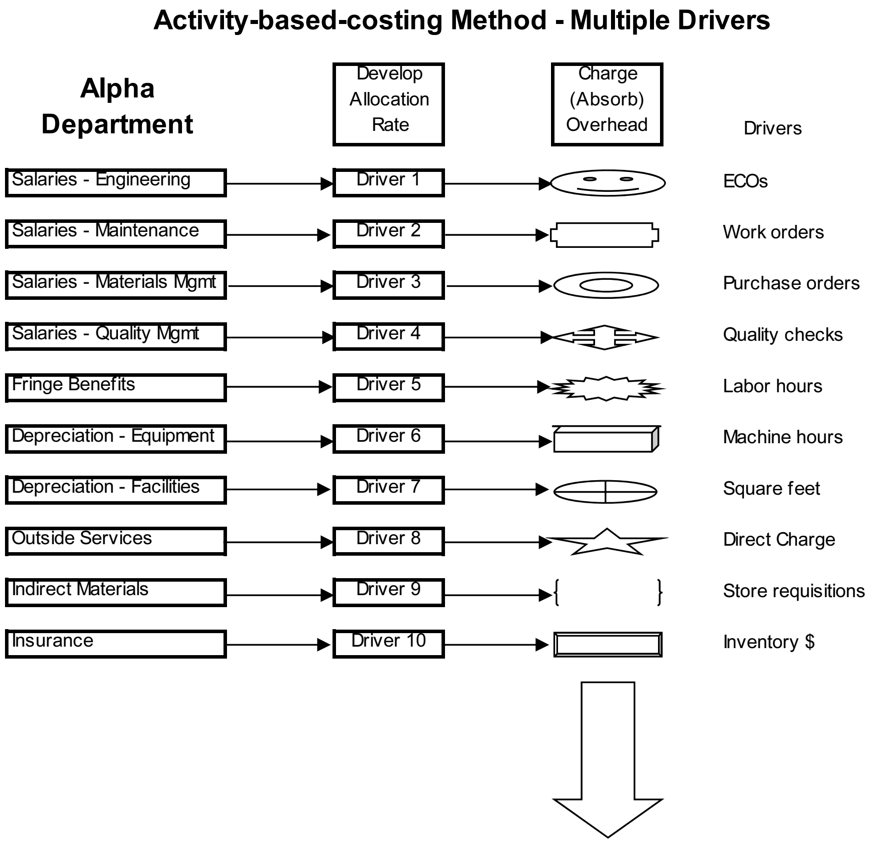

Figure 8A.2. ABC method of allocating overhead.

they "absorb" engineering salary overhead based on the number of ECOs required. Each overhead cost is handled the same way so that the number of overhead allocation steps varies with the number of cost drivers selected.

Techniques or Technologies Used (Quantitative or Qualitative)

The major technique used in ABC is to determine the causes (drivers) of the indirect costs that cannot be assigned directly to a product. If costs can be assigned directly, they should be, such as direct materials, through the bill of materials, direct labor through a process sheet, and indirect labor through organization structure.

When costs cannot be assigned directly, they must be allocated to products or processes through those activities that best reflect the relationship between activity and cost. This is the heart of ABC. Selecting the correct cost drivers determine the effectiveness of the ABC results.

Maskell (1991) offers the following suggestions in selecting drivers:

1. Do not attempt to include all, or even the majority, of overhead costs into activity-based cost drivers.
2. Limit the number of drivers. Use an 80/20 approach in the early stages (20% of the possible drivers will cover 80% of the costs) and refine as a result of experience with the system.
3. Educate those using the results in the concepts and practical use of activity-based costing.
4. Use the experience and common sense of the managers and supervisors in the plant and offices when selecting drivers.
5. Determine the level at which the costs should be applied; they do not have to be applied to individual products.
6. Consider the use of a different, simpler method of calculating inventory values for financial accounting purposes.
7. Above all, keep the activity-based accounting system simple.

Objectives (Reasons for Adopting Program)

The primary objective of ABC is to determine more accurately the costs incurred in manufacturing products or providing services. Direct material and direct labor costs can usually be assigned directly through use of the product's bill of material and the list of operations to be performed. However, the assignment of overhead costs becomes more difficult, especially as product complexity increases.

The secondary objective is to use this improved cost information effectively in the business. Product costs can be determined more accurately, opportunities for cost reduction can be more easily identified, budgets can be constructed with greater sensitivity, and managers can be more confident in their decision-making as a result of more valid cost information.

An increasing overhead base and a shrinking direct labor base motivated the need for a more comprehensive way to allocate overhead costs to products. The overhead rates used in most companies have become large enough to make it easy to distort individual product costs. A second reason is the increase in diversity of products and services, which makes traditional management accounting methods obsolete.

ABC does not have cost improvement as a primary objective. It will generate new ways of looking at cost information but cost reduction initiatives are not included in the cost system.

An ABC system does not replace the need for a financial accounting system. The external reporting requirements for agencies such as the SEC, IRS and other regulatory agencies have specific reporting requirements. ABC is for management accounting, not financial accounting purposes.

ABC is not appropriate for all companies. The benefits may not justify the investment and disruptions to the company's operations. There is a model that offers a company the opportunity to evaluate the appropriateness of ABC for themselves. It requires subjective, but systematic, evaluation of two main areas: (1) the potential for ABC to develop significantly different product costs from the present system; and (2) the likelihood that management can use the cost information for constructive action. The first area considers product diversity, support service diversity, commonality of processes among products, extent of period cost allocation and rate of growth of period costs. The second area includes pricing freedom, period expense to total cost ratio, strategic considerations, potential for cost reduction, and cost analysis frequency. When there is both the likelihood that ABC will generate significantly different costs and that management can use these costs to make improvements, ABC is an attractive program to implement (Estrin, 1994).

History (Time Line, Reasons Originated, Principal Developers)

Activity-based costing came into prominence during the early 1990s. Johnson and Kaplan (1987) set the stage with their book in 1987, in which they pointed out the breakdown in management accounting systems and advocated the need for new and improved management accounting. Berliner and Brimson (1988) described a new conceptual design for a cost management system that also included the need to include the use of "activity accounting." There is some evidence that more precise allocation of overhead costs to products had advocates even earlier. Latshaw (2002) suggests GE did work in the 1960s and Henrici (1947) describes a way to assign overhead costs directly to products. Krumwiede described the results of a 1996 Institute of Management Accountants (IMA) survey that approximately one-half of the companies surveyed had adopted ABC and, of those adopters, 89% said it was worth the implementation costs (Krumwiede, 1998).

Traditional costing systems in existence prior to the 1980s emphasized short-term planning and control, decision making, and product costing. First-generation activity-based costing (ABC) emphasized product costing, with the major output a better product-costing cost accounting system. In this ABC system, continuous improvements are made to processes that impact the costs of products. Second-generation systems included resources as well as processes, with performance measurements receiving as much attention as product costs. Although these activities are still internal, the scope of the internal activities is greatly enhanced. A 3rd-generation ABC system focuses on the business unit and its relationships with others inside and outside the business unit. It links activities to processes and then processes to a business unit. The next logical step, for 4th-generation ABC, would seem to be linking activities between business units together, creating an ABC system that provides information for the company as a whole (Mecimore, 1995).

Figure 8A.3 shows the number of articles published with ABC as the main theme. The first articles were written in the late 1980s. They peaked in the 1990s and have seen a slight decline during the last decade, although still a fairly active topic, especially in scholarly journals, where

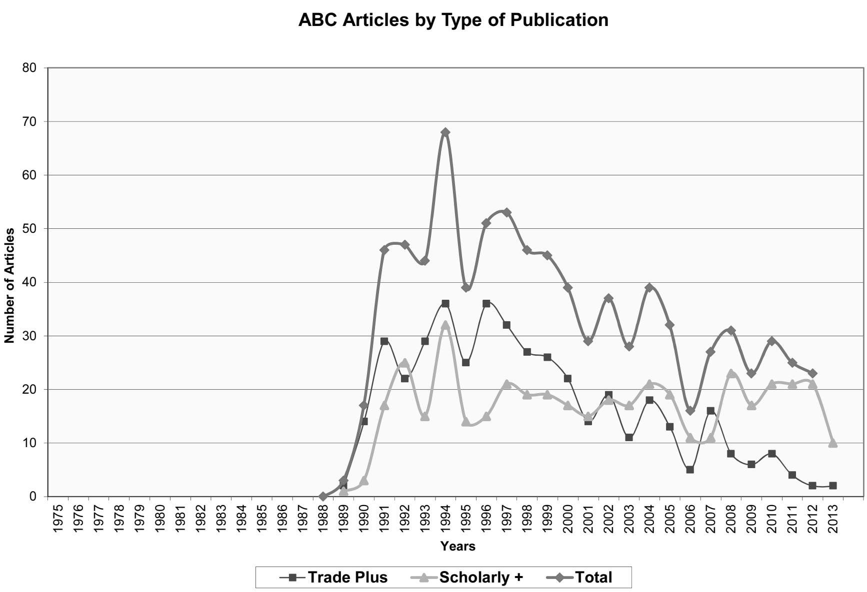

Figure 8A.3. Number of ABC articles.

the number of articles have remained steady at around 20 articles per year.

There is another time line for ABC. There are four management accounting paradigms: (A) the era of the industrial revolution through the 1940s, with emphasis on standard costs; (B) the cost-volume-profit analysis and direct costing era (1940s until the 1980s); (C) the activity-based-costing era (late 1980s through the early 1990s); and (D) the market-driven, as opposed to engineering-driven, allowable or target cost era (1990s and beyond). Ferrara (1995) suggests that C will have to be combined with D and perhaps some elements of B for optimum results.

While the early applications of ABC were in manufacturing companies, in recent years there have been more applications in functional service areas such as distribution, marketing, engineering and research and development. There are examples of use in services industries such as health care, banking and retailing.

Expected Benefits (Tangible and Intangible)

Some of the benefits expected from ABC include product pricing, production decision making (mix, volume, and others), overhead cost reduction, and continuous improvement approaches (Maskell, 1991).

Obstacles

ABC is primarily a method of identifying costs and providing clues that will help reduce costs. It does not have, as a primary purpose, improvements in quality, delivery times or supply flexibility.

An IMA survey found several factors affect the success of an ABC implementation. They include:

- Time required. ABC often takes more time to implement than expected. The amount of time required varies with the size of the company. Smaller companies (less than $100 million reported an average time of 2.3 years while larger firms reported an average time of 3.6 years. Time was found to be the most important factor in the study for differentiating usage and nonusage companies.
- Interference from other major initiatives. Sixty-two percent of the firms that have not reached the usage stage report other major initiatives being implemented.
- Information technology sophistication. A high level of IT sophistication appears to be an important factor in getting to the usage

stage for the majority of companies. In general, companies will have an easier time implementing ABC if their IT system has the following characteristics: good subsystem (for example, sales system or manufacturing system) integration; user-friendly query capability; available sales, cost, and performance going back 12 months; and real-time updates of all these types of data.

- Top management support. Fifty-eight percent of the usage-level companies had a high level of top management support versus 40% for the nonusage companies.
- Integration into financial system. Using ABC cost information in financial reporting generally will lead to its use in decision making. Of the usage stage companies, 47% say they have integrated ABC into their primary financial system. Auditors gave their OK to the ABC system because it provided full absorption costing.
- Part of the budgeting process. Of the ABC users, 45% listed budgeting as one of the reasons for using it. As a general rule, companies should report actual costs using the same method that is used to develop the budget (Krumwiede, 1998)

Some companies may decide to not implement ABC because they are unable to cost justify the investment requirements. Quantifying the benefits of ABC can be difficult.

IMPLEMENTATION STEPS

Ainsworth describes the following implementation process. To effectively implement an ABC system, the accountant must have a thorough understanding of the production process. The accountant must understand the flow of product throughout the facilities, the wait time incurred by the product line, the flow of paperwork throughout the process and the activities needed to produce a product—both manufacturing and nonmanufacturing. One of the benefits of an ABC costing system is the ability to treat more costs as variable rather than fixed and to identify and eliminate or reduce nonvalue added costs. The following nine steps provide a framework for implementing an ABC system.

1. Define all activity centers. An activity center is a department or branch where similar activities occur.
2. Prepare a detailed flow chart of the entire manufacturing process starting from procurement of raw materials to the shipment of finished goods to determine all of the manufacturing activities.

3. Determine exactly what activities occur in each activity center. This will require extensive input from those in control of the activities.
4. Define activities as value-added or nonvalue-added. A value-added activity is one that is required to meet the customer's product specifications.
5. Analyze any activities defined as nonvalue-added to determine if they can be eliminated or reduced. A value-added activity is one which the customer needs. A nonvalue-added activity is one which the customer does not require.
6. Determine a cost driver for each activity differentiated above. A cost driver is the factor that causes the cost of the activity to change.
7. Determine the activity application rate by dividing the cost of the activity by the budgeted amount of the cost driver.
8. Apply the new manufacturing activities costs to the products by multiplying the activity application rate by the actual usage of the manufacturing resources.
9. Prepare a production analysis report for management outlining what has been discovered about product costs in the company through this process (Ainsworth, 1994).

Some additional implementation tips are:

- Focus on critical needs.
- Get top management support.
- Try to include ABC in the main cost system.
- Consider a separate model, If integrating ABC into the main cost reporting system is not feasible.
- Make sure ABC can be supported by the existing information system.
- Smaller companies need to be especially creative to find reasonable activity cost drivers from their often more limited data.
- Make sure the people who will be actual users of the ABC information are represented on the implementation team.
- Select the right software (Krumwiede, 1998).

The following are examples of the successful use of ABC. Many more examples can be found in the referenced books and articles.

Manufacturing (printed circuit assemblies). Hewlett-Packard was one of the early users of ABC. It installed ABC in one of its UK plants to provide better information for strategic decision making, for accurately calculating individual product costs, and for valuing inventory for financial accounting purposes (Maskell, 1991, p. 371).

Marketing and distribution. One company used ABC to segregate and allocate marketing activities—selling, advertising, warehousing, packing and shipping, and general office—and assigned these costs to products. They used the cost information for profitability analysis, pricing, and adding or dropping the product lines or territories (Lewis, 1991).

Services (hospice). Hospice of Central Kentucky (HCK) uses ABC to help it negotiate with insurance companies for their services. As a result, they were able to agree on a type of payment that is nearly always advantageous to the hospices and the patient (Baxendale, 2000).

Future

ABC has probably reached its peak in manufacturing companies, although there may be limited application remaining in small companies. However, ABC has potential as an application in service industries, especially in health care where there is a great need for identification for identifying cost drivers and the costs associated with those drivers.

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CHAPTER 8B

ACTIVITY-BASED MANAGEMENT (ABM)

NAME AND BRIEF DEFINITION

Activity-based Management (ABM)—The use of activity-based costing information about cost pools and drivers, activity analysis, and business processes to identify business strategies; improve product design, manufacturing, and distribution; and remove waste from operations. See: activity-based costing (Blackstone, 2013).

Activity-based Management (ABM)—A discipline that focuses on the management of activities as the route to continuously improving the value received by customers and the profit achieved by providing this value. This discipline includes cost driver analysis, activity analysis, and performance analysis. ABM draws on activity-based costing as a major source of information (Turney, 1993).

Activity-based costing (ABC) was the predecessor to ABM. As more meaningful cost information became available, it was a natural progression to use this information to make improvements in costs, quality and customer service. The concept of Activity-based Planning and Budgeting (ABPB) has received some attention, especially by the CAM-I group (Sandison, 2003). The Balanced Scorecard concept followed along after ABM to focus businesses on the need to develop a strategic approach in the management accounting area.

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 237–245
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Objectives (Reasons for Adopting Program)

Activity-based management (ABM) or Activity-based cost management (ABC/M), as it is called by some writers, is a system that uses activity-based cost information to identify opportunities to reduce costs or improve service. "ABM and ABC are made for each other. ABC supplies the information, and ABM uses this information in various analyses designed to yield continuous improvement" (Turney, 1993).

History (Time Line, Reasons Originated, Principal Developers)

ABM followed closely—in the early 1990s—the development of Activity-based Costing (ABC), as businesses began to develop a more systematic approach to using the cost information developed in the ABC programs.

While the early ABC systems were concerned primarily with assigning the correct costs to products, it soon became apparent that the increased visibility into the activities and their related costs offered the opportunity for analysis leading to cost improvement initiatives. These initiatives could lead to improved quality and customer service as well as reduced costs. Thus, the management of activities costs became an identifiable program.

Kaplan is given credit for leading the change to ABC. Peter Turney is one of the early advocates of ABC and ABM. Berliner and Brimson wrote about the CAM-I cost management conceptual design and later Brimson and Antos published another book describing the application of ABM to service industries. Gary Cokins has written extensively about ABM, beginning in the mid-1990s and continuing through the new decade.

As shown in Figure 8B.1, ABM articles trailed ABC by only a year or so. ABM articles peaked in the late 1990s and has declined since. Some overlap probably exists between ABC and ABM, where there is not a clear distinction between the two.

Expected Benefits (Tangible and Intangible)

ABM supports a number of improvement initiatives beyond just assigning the correct costs to products and services, such as those listed below:

- Use strategic analysis to find profitable opportunities to reprice products or services, redirect resources, and change product strategy,

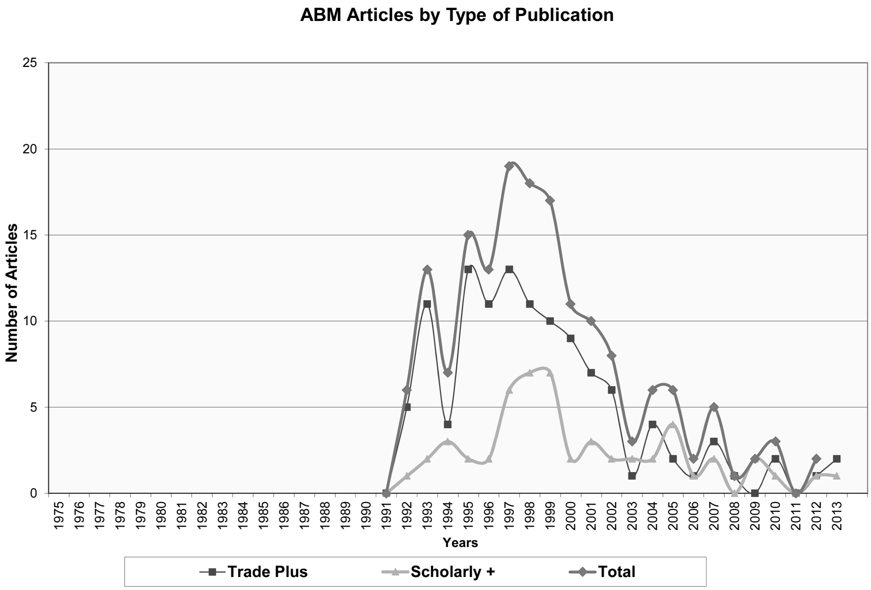

Figure 8B.1. Number of ABM articles.

- Apply value analysis to improve business processes and reduce cost,
- Perform cost analysis to identify cost reduction opportunities and communicate what's learned from the improvements,
- Complete activity-based budgets to estimate work load and resource requirements and to direct resources and activities to the most strategically valuable purposes,
- Use life-cycle costing to make strategic judgments and identify cost reduction opportunities over the life of a product, and
- Use target costing to design products to meet a predetermined cost (Turney, 1993).

A survey (Kiani & Sangeladji, 2003) of 44 Fortune 500 companies in a variety of industries identified the following benefits, in descending order of value (the range of benefits was from moderate down to somewhat):

- Improvement in overall profitability
- Reduction in the manufacturing costs of products
- Development of more profitable products
- Reduction in the number of design changes after production began

- Reduction in the expected costs of new products before manufacturing
- Reduction in the cost of purchased materials
- Reduction in the time required for new product information

In short, ABM analyzes the successes and problems in the use of ABC to identify further improvement opportunities.

Obstacles

The American Productivity and Quality Center and the Consortium for Advanced Manufacturing International sponsored a study to identify best practices in activity-based costing and activity-based management (ABC/M). Some common themes emerged as being particularly important to successful ABC/M implementations. In particular, management commitment and support, the technical competence of the implementation team, and effective change management are critical to many companies. When asked whether using the ABC/M information resulted in quantifiable financial improvements, the survey respondents reported relatively modest results. However, when key managers use their perceptions to measure the ABC/M project's success, the results were much more favorable. These managers often based their opinions on expected future savings. These expectations might be reasonable, since most of the respondents have had ABC/M in place for less than two years (Swenson & Barney, 2001).

In this survey, they identified the primary application areas as product costing, cost reduction, profitability analysis, process improvement, cost estimation, performance measurement, pricing models, business process re-engineering, benchmarking, target costing, inventory valuation, capacity utilization, and budgeting. The survey respondents reported some to significant improvements in production/manufacturing, overhead support, product/service profitability, product/service design, customer service, and sales and marketing.

The responding companies reported wide variation in their levels of success with ABM; however, certain firm characteristics emerged as being important to successful ABM implementation: top management commitment and support, technical competence, and effective change management.

The survey by Kiani and Sangeladji (2003) revealed the following difficulties encountered in applying ABC and ABM (in descending order of difficulty):

- Did not get top management sponsorship/support
- People are unwilling to change
- Lack of adequate competent personnel
- Complexity in process design
- Takes too long to implement these systems
- Complexity in plant (manufacturing) layout
- Complexity in product design
- Lack of adequate cooperation from suppliers
- ABC or ABM is not relevant for our kind of business
- Returns from expenditures on these systems are inadequate

The companies involved in the above survey had used ABM for the following periods: 48% for 0–2 years, 34% for 2–4 years, and 18% for over 5 years.

Implementation

Brimson and Antos (1994) recommend the following approach to implement an activity-based management system. The first four steps describe the activity-based costing system; the last two steps constitute the activity-based management phase of the system.

1. Determine enterprise activities.
2. Determine activity cost and activity performance. Measure performance as the cost per output, time to perform the activity, and the quality of the output.
3. Determine the output and output measure of the activity. An activity measure (output measure) is the factor by which the cost of an activity varies most directly. The output is simply what is produced by that activity.
4. Trace activity cost to cost objectives. Cost objectives include services, business processes, customers, channels of distribution, and orders based on the usage of the activity.
5. Determine organization short- and long-range goals (critical success factors). This requires understanding the current cost structure, business processes, and operating activities, and how effectively they deliver value to the customer.
6. Evaluate the activity/business process effectiveness and efficiency. Knowing the critical success factors (step 5) enables an organization to examine what it is now doing (step 4) and the relationship

of that activity to achieving organization goals through long-term customer satisfaction at the lowest possible cost. An organization should measure everything it does—or avoids doing—against their short- and long-term goals. This provides a useful formula on which to base a decision of whether to continue performing or to restructure an activity/business process. In addition, improved cost control results from ascertaining whether there are superior methods of performing an activity/business process, identifying wasteful activities, and determining the cause of the cost.

Major Components (Changes Required)

Cokins (2001a) describes the following stages of cost management systems. He explains that he is extending the four-stage model first presented by R. S. Kaplan and R. Cooper in their book, *Cost & Effect* (Boston: Harvard Business School Press, 1998).

Cokins (2001a) further explains each of the stages as follows:

Stage 1: **Broken**. Cost management systems are primitive and fairly useless for managing an enterprise, as in a small business without a formal record-keeping system.

Stage 2: **Financial Reporting Driven**. Companies use cost management systems to comply with external reporting for bankers or owners or to government agencies, such as for tax reporting. The financial data may minimally meet the reporting requirements, but they may distort the true costs and profit margins of the specific products or service lines sold. Late reporting or excessive aggregation of this information will make it difficult to gain any insights about where to focus improvement activities or what cost areas to better control.

Stage 3: **Customized/Stand-Alone**. In this stage, companies design cost management systems to provide reasonable accuracy and visibility for decision-making. Activity-based costing begins to emerge. The variety and diversity of the products and service lines of these organizations will have expanded so much that indirect and support overhead expenses will have become a significant portion of the cost structure. Simplistic cost allocations, usually volume-based, are no longer sufficient to reflect how much the individual outputs consume those expenses.

Stage 4**: Integrated**. Cost management systems are what many organizations desire. Linking databases to the calculation logic makes it possible to trace the expenses to processes and to outputs. The resulting information facilitates monitoring performance or simply to more accurately report spending for control or for profit margin performance. The reporting is highly automated and supported by powerful query and analysis tools. The distribution of the calculated results is more widely accessible to various users throughout the organization.

Stage 5: **Decision Support**. This cost management system represents more of a profit management and value management system. It goes well beyond simply calculating and distributing accurate and relevant cost information, by providing information, and the flexibility to configure assumptions, for decision-making. It provides a logical and defensible tracing of expenses so that managers and employee teams can gain insights into and make inferences about where to focus and what to change.

Techniques or Technologies Used (Quantitative Or Qualitative)

ABM is the catalyst for searching out the opportunities for continuous improvement. ABC information enables ABM to guide the continuous improvement process. It helps direct resources to activities that yield the greatest profitability and helps improve the organization effectiveness and efficiency.

Turney (1992) describes an approach to eliminating waste and strengthening strategic position:

Analyze activities to identify opportunities for improvement.

- Identify nonessential activities.
- Analyze significant activities.
- Compare activities to the best practices.
- Examine the links between activities.
- Dig for Drivers.
- Measure what matters.
- Determine the mission.
- Communicate the objectives.
- Develop the measures.

Reduce costs by managing activities

- Reduce time and effort.
- Eliminate unnecessary activities.
- Select low-cost activities.
- Share activities whenever possible.
- Redeploy unused resources.

Major Users (Companies or Industries)

Major users include the Coca-Cola Company, DeLuxe Check, Navistar, and Allied Signal Corporation (Cokins, 2001a) and General Motors, Hewlett-Packard, Siemens, Tektronix, Black and Decker, General Electric, and AT&T are all managing activities as the route to business improvement (Turney, 1993).

Brimson and Antos (1994, Appendix) documented examples of service businesses that have successfully implemented ABM practices, including: banks/savings and loan, Federal government reimbursement for processing disability claims, transportation company budgeting department, computer systems integration company, insurance underwriting, defense contractor's audit agency, selling phone book yellow pages, college accounts payable department, hospitals, airlines, restaurants, telecommunications power transmission lines and the U.S. postal service.

Program Life Cycle Stages (Development, Acceptance, Growth, Maturity, Decline)

An ABM program begins after the implementation of an ABC program. Once activity cost information is available, companies want to use the information in their analysis and planning activities. The ABM program becomes entrenched in a company's regular management practices. Mature ABM users also want to use the program to support their ongoing improvement programs, such as TQM, change management, lead time reduction, target costing, and other similar programs.

More recently, there are new issues for the advanced and mature AABM users, such as:

- Integrating the ABC/M output data with their decision-support systems, such as their cost estimating, predictive planning, activity-based budgeting (ABB) systems, customer relationship management (CRM), and balanced scorecard performance measurement systems.
- Learning the skills and rules for resizing, reshaping, releveling, and otherwise readjusting their ABC/M system's structure in response to solving new business problems with the ABC/M data.
- Collecting and automatically importing data into the ABC/M system.
- Automatically exporting the calculated data out of their ABC/M system.

It is evident that among experienced ABC/M users, ABC/M eventually becomes part of the core information technologies (Cokins, 2001b).

Future

ABM, as a separate program, appears to have little future as a separate program. Its features have been largely included in ABC or replaced by the Balanced Scorecard (BSC) approach.

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CHAPTER 8C

BALANCED SCORECARD (BSC)

NAME AND BRIEF DEFINITION

Balanced Scorecard—A list of financial and operational measurements used to evaluate organizational or supply chain performance. The dimensions of the balanced scorecard might include customer perspective, business process perspective, financial perspective, and innovation and learning perspectives. It formally connects overall objectives, strategies, and measurements. Each dimension has goals or measurements (Blackstone, 2013).

The Balanced Scorecard is an outgrowth of the activity-based costing (ABC) and activity-based management (ABM), which Kaplan spearheaded in the 1980s. ABC helps to organize the collection of more meaningful cost information. ABM helps to take the cost information and analyze it to take meaningful action to correct or improve operations. The Balanced Scorecard builds on ABC and ABM by using the results of these and other programs, to develop a forward look at operations and strategies. Other programs, such as JIT and TQM, may be an outgrowth of the strategic planning process, using the Balanced Scorecard.

Objectives (Reasons for Adopting Program)

The Balanced Scorecard emphasizes that both financial and nonfinancial measures are needed to manage a business. It is more than an opera-

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tional measurement system; it is also a strategic management system. Some of the more specific objectives include the following (Frigo, 2003; Hepworth, 1998; Kaplan, 1994):

- It is a measurement tool that measures the most meaningful activities in the business.
- It is an analysis tool that helps to interpret the results, as compared with plans.
- It helps to translate a company's vision into strategies.
- It focuses attention on the most meaningful performance measures.
- It provides a means of communication among functional areas of the business.
- It measures the past to provide an insight into the future.
- It helps to integrate the strategic plan with the annual, or business, plan.
- It utilizes multiple measures to provide a holistic view of the business.
- It strives for balance between financial and nonfinancial measures, internal and external perspectives, and operational and strategic planning.

The Balanced Scorecard is a versatile and powerful tool when incorporated into the overall management structure of a company. However, it does not manage a business; it only helps managers to manage better.

History (Time Line, Reasons Originated, Principal Developers)

Kaplan and Norton developed the Balanced Scorecard in the early 1990s. In a milestone article in the Harvard Business Review, Kaplan reports: "During a year-long research project with 12 companies at the leading edge of performance measurement, we devised a 'balanced scorecard'—a set of measures that gives top managers a fast but comprehensive view of the business. The balanced scorecard includes financial measures that tell the results of actions already taken. And it complements the financial measures with operational measures on customer satisfaction, internal processes, and the organization's innovation and improvement activities—operational measures that are the drivers of future financial performance" (Kaplan, 1992).

Kaplan and Norton followed with numerous articles and a book in 1996. Other writers have reported on the implementation results for a

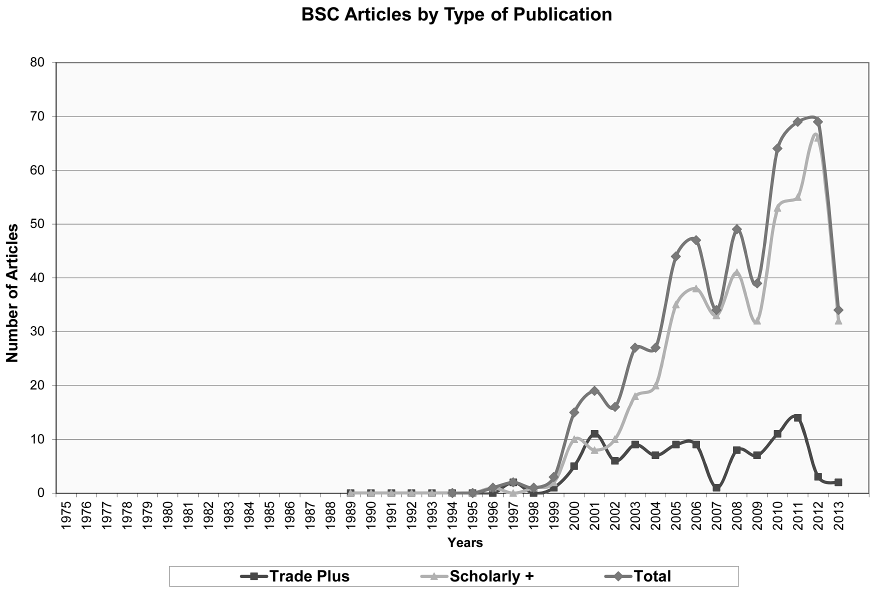

Figure 8C.1. Number of Balanced Score Card articles.

number of companies. A 1999 survey reported that 44% of the companies surveyed used the Balanced Scorecard. Of those using it, 18% were "extremely satisfied" while 7% were "dissatisfied" (Rigby, 2001).

The concept is well received. The early applications were in manufacturing; however, there are numerous cases of applications in service companies and nonprofit businesses. Figure 8C.1 shows the first articles about BSC were published in the early 1990s. Some of the earliest articles did not include the BSC acronym, which began appearing about 1996. Since then, the number of articles has steadily increased, primarily in scholarly journals. As with ABC, researchers have found BSC to be a rich area to study.

Major Components (Changes Required)

The major components of the Balanced Scorecard system consist of four major areas:

- Customer perspective or How Do Customers See Us?
- Internal business perspective or What Must We Excel At?

- Innovation and learning perspective, or Can We Continue to Improve and Create Value?
- Financial perspective or How Do We Look to Shareholders?

The name comes from attempting to create a "balance" among each of the four perspectives (Kaplan & Norton, 1996).

Techniques or Technologies Used (Quantitative or Qualitative)

The Balanced Scorecard is a different approach to the strategic planning process. As with most strategic planning initiatives, it requires top management support and active involvement. The approach to scorecard design is logical and systematic. The concept is easily understood; the implementation challenge is in gaining acceptance throughout the organization, not in the design technology.

The measures selected for performance assessment are often nontraditional. Kaplan (1992) describes several examples:

For the Customer's Perspective

- A computer manufacturer wanted to be the competitive leader in customer satisfaction, so it measured competitive rankings. The company got the rankings through an outside organization hired to talk directly with customers. The company also wanted to do a better job of solving customers' problems by creating more partnerships with other suppliers. It measured the percentage of revenue from third-party relationships.
- The customers of a producer of very expensive medical equipment demanded high reliability. The company developed two customer-based metrics for its operations: equipment up-time percentage and mean-time response to a service call.
- A semiconductor company asked each major customer to rank the company against comparable suppliers on efforts to improve quality, delivery time, and price performance. When the manufacturer discovered that it ranked in the middle, managers made improvements that moved the company to the top of customers' rankings.

For the Internal Business Perspective

- One company recognized that the success of its TQM program depended on all its employees internalizing and acting on the program's messages. The company performed a monthly survey of 600 randomly selected employees to determine if they were aware of TQM, had changed their behavior because of it, and believed the outcome was favorable, or had become missionaries to others.

- Hewlett-Packard uses a metric called breakeven time (BET) to measure the effectiveness of its product development cycle. BET measures the time required for all the accumulated expenses in the product and process development cycle (including equipment acquisition) to equal the product's contribution margin (the selling price less manufacturing, delivery, and selling expenses).
- A major office products manufacturer, wanting to respond rapidly to changes in the marketplace, set out to reduce cycle time by 50%. Lower levels of the organization aimed to radically cut the times required to process customer orders, order and receive materials from suppliers, move materials and products between plants, produce and assemble products, and delivery products to customers.

Benefits

Kaplan (1996) outlines some of the benefits of the Balanced Scorecard as:

- Clarify and gain consensus about vision and strategy
- Build a management team
- Communicate the strategy
- Link reward to achieving strategic objectives
- Set strategic targets
- Align resources and strategic initiatives
- Sustain investment in intellectual and intangible assets
- Provide a foundation for strategic planning

Realizing the softer benefits listed above should lead to improved financial results for the company.

An early survey by Rigby (2001) of 25 management tools and techniques revealed that the Balanced Scorecard ranked as follows:

- Percent of Respondents Using Tool (44%, or 12th of 25 tools)
- Mean Satisfaction Level of Users (3.85 of 5.00 or 8th of 25 tools)
- Tool Satisfaction (17.6% extremely satisfied; 6.6% dissatisfied)
- Tool Defection Rate (11.3%, or 12th of 25 users)

These results indicate that the Balanced Scorecard rates well with users, especially considering its short time as a defined management tool.

Obstacles—Costs or Investment Requirements (Resources Required)

Implementing the Balanced Scorecard does not require major investments in capital equipment or facilities. There may be some additional information processing requirements, especially in collecting information about the key performance measures selected in the scorecard design.

While the capital investment may be limited, the major cost will be in the time required by key managers in designing and implementing the system. This will also contribute to the relatively long time to implement the system, which can be upwards of two years.

Kaplan and Norton describe several companies in their book and related articles.

- National Insurance Company (Kaplan, 1996).
- A manufacturing company they call Electronic Circuits Inc. (ECI) (Kaplan, 1992)
- Rockwater, an undersea construction company (Kaplan, 1994)
- Metro Bank (Kaplan, CMR 1996)

Obstacles

The Balanced Scorecard does not focus on a specific problem or opportunity; it helps to identify the problems or opportunities and to build strategies to correct or improve. The major obstacle is probably the need to link several areas of an organization into one reporting system and to report the results on a regular basis.

Implementation Steps

The implementation process for the Balanced Scorecard varies with each company. However, Kaplan and Norton (1996) describe a general, four-step approach in their book as follows:

Define the Measurement Architecture

Task 1. Select the appropriate organizational unit. Designing a scorecard for an entire company is difficult; a strategic business unit that will benefit from using a scorecard should be selected first.

Task 2. Identify SBU/Corporate Linkages. The project manager interviews key senior managers to learn about financial objectives for the SBU, overriding corporate themes, and Linkages to other SBUs (common customers, core competencies, opportunities for integrated approaches to customers, internal supplier/customer relationships)

Build Consensus around Strategic Objectives

Task 3. Conduct First Round of Interviews—to introduce the Balanced Scorecard concept to senior managers and to get their input about objectives and strategies of the company.

Task 4. Digest the input from the interviews, to highlight issues, and to develop a tentative list of objectives and measures that will provide the basis for the first meeting with the top management team.

Task 5. Executive Workshop: to gain consensus on mission and strategy statements and to begin the selection of performance measures. Select group leaders for each of the four groups within the scorecard.

Select and Design Measures

Task 6. Subgroup Meetings. The project manager meeting with the individual subgroups to accomplish four principal objectives:

- Refine the wording of the strategic objectives.
- For each objective, identify the measure(s) that best capture and communicate the intention of the objective.
- For each proposed measure, identify the sources of the necessary information and the actions required to make this information accessible.
- For each perspective, identify the key linkages among the measures within the perspective, as well as between other scorecard perspectives.

Task 7. Executive Workshop: Second Round. Finalize on the vision, strategy statements, and the tentative objectives and measures for the scorecard. Senior managers should participate and assume ownership for the objectives and measures, as well as the entire scorecard process.

Build the Implementation Plan

Task 8. Develop the Implementation Plan. The plan should include how the measures link to database and information systems, communicating the Balanced Scorecard throughout the organization, and encouraging and facilitating the development of second-level metrics for decentralized units.

Task 9. Executive Workshop: Third Round. The senior executive team meets to finalize the vision, objectives, and measurements developed in the previous workshops; and to validate the stretch targets proposed by the implementation team.

Task 10. Finalize the Implementation Plan. Integrate the Balanced Scorecard into the organization's management system.

Businesses in a variety of industries, both manufacturing and service, use the Balanced Scorecard. It has universal application because each business can tailor its objectives and measures as they see fit.

The Balanced Scorecard concept has advanced from the start-up phase of a program life cycle and is in the growth stage. It has gained widespread acceptance as a practical approach to integrating various aspects of a business into the strategic planning process. It does not have major front-end costs associated with its inception; in fact, some of the benefits occur quickly during the analysis necessary to design the scorecard for a company.

Future

New applications for the BSC continue to appear in the literature. The original developer of the BSC, Kaplan and Norton, are still active in refining the concept and making it available in wider circles of application. It appears to be a program that has widespread use in all types of organizations.

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The Balanced Scorecard Institute—http://www.balancedscorecard.org/

CHAPTER 8D

KEY PERFORMANCE INDICATORS (KPI)

NAME AND BRIEF DEFINITION

Key performance indicator (KPI). A financial or nonfinancial measure that is used to define and assess progress toward specific organizational goals and typically is tied to an organization's strategy and business stakeholders. A KPI should not be contradictory to other departmental or strategic business unit performance measures (Blackstone, 2013). KPIs represent a set of measures focusing on those aspects of performance that are most crucial for the continued success of an organization. There are only a few in any one firm and they have a profound impact if they are monitored constantly. A few KPIs can be measured weekly, but most should be measured more frequently (Parmenter, 2007).

Typical characteristics of true key performance indicators suggested by Parmenter (2007) include:

- They are non-financial measures.
- They are measured frequently.
- They are acted upon regularly by the chief executive and the top management team.
- All employees understand them and what corrective action they indicate.
- Responsibility for KPIs can be attributed to teams or individuals.

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- They have a significant impact on the organization (e.g., they affect most of the core critical success factors and aspects of a balanced scorecard).
- Positive results on KPIs affect other measures positively.

There is a difference between a Metric and a Key Performance Indicator. A metric is simply a measure of something. A performance metric is a measure of some activity related to a company's business performance. What, then, is a key performance indicator (KPI)? A KPI is a special kind of metric. It measures something that is strategically important to the business in question. In other words, a KPI is a metric that matters. A company can have many metrics, but should only have a handful of KPIs. Everything can't be considered "key," or nothing will stand out from the pack and get the attention it deserves. In a typical performance system, there are an average of 12 to 25 KPIs and potentially hundreds of supporting metrics. An even more important concern is that KPIs should be assigned to individuals with responsibility to address them, and a plan should be in place to take action if a KPI passes a certain threshold (Schiff, 2008).

There is also a difference between a Dashboard and a Scorecard. These terms have been used interchangeably by both end users and vendors for many years. However, they mean different things. When managers talk about tracking performance by looking at key measures, they are really talking about a scorecard. A scorecard is the collection of measures used to determine how well a company is executing its strategy. In effect, it is a report card on the organization's performance. One common type is the balanced scorecard. These measures can be displayed numerically in a report; however, they are more effective when displayed graphically. That is where the dashboard comes into play. A dashboard is a graphical display, ideally suited to share the status of the various performance measures that make up the scorecard. Dashboards use familiar objects such as gauges, stoplights and graphs to make the performance information more intuitive to a wider audience. The term "performance management dashboard" indicates a dashboard tool that contains a scorecard of performance data (Schiff, 2008).

Objectives (Reasons for Adopting Program)

The primary objectives of KPIs are to:

- Provide near real time performance measures that are important and accepted as meaningful by those entities or processes being measured.
- Use physical measures that are more tangible, understandable and measureable to operations managers than financial measures that

are often summarized, rather than specific, and lag actual operations.

The alignment of KPIs with organization vision/mission/strategies/objectives is the key to realizing bottom-line impact. The challenge is to develop KPIs that provide a holistic and balanced view of the business (Bauer, 2004).

No single KPI can provide a comprehensive view of the overall situation. A performance management system should focus on multiple factors including cost, productivity, quality, employees, supplier issues, and strategic alignment. In strategic alignment, a possible measure could include the number of suppliers that represent a high percentage of the total spend (Kaskinen, 2007).

History (Time Line, Reasons Originated, Principal Developers)

Even though dashboards and scorecards may seem relatively new, they are actually evolutionary developments. In the late 1970s, Jack Rockart introduced and popularized the critical success factors (CSFs) concept, which identifies and monitors what companies, business units, departments, and individuals must do well in order to be successful. As executive information systems (EISs) became popular in the 1980s, CSFs and key performance indicators were important components. In many ways, today's dashboards and scorecards are the EISs of yesterday because of their focus on key performance metrics. The most important similarity is that both systems contain metrics that communicate what is important, monitor what is taking place, and help people be successful in their work. Metrics are displayed in dashboards in both systems. Scorecards go beyond dashboards. They explicitly link the dashboards to business strategy. This linking is the most significant difference between the two. Vendors offer software that facilitates the development and use of scorecards and dashboards, and the same technology can also be used for enterprise reporting (Watson, 2006).

Figure 8D.1 shows the number of article published about KPIs. Although the concept has been around much longer than indicated in the diagram, its identification as a specific management program is relatively new. As shown in the graph, scholarly articles are just beginning to come into prominence.

Expected Benefits (Tangible and Intangible)

The obvious benefit of KPIs is to gain improved performance in whatever area the KPI measures. It may be cost reduction, quality improve-

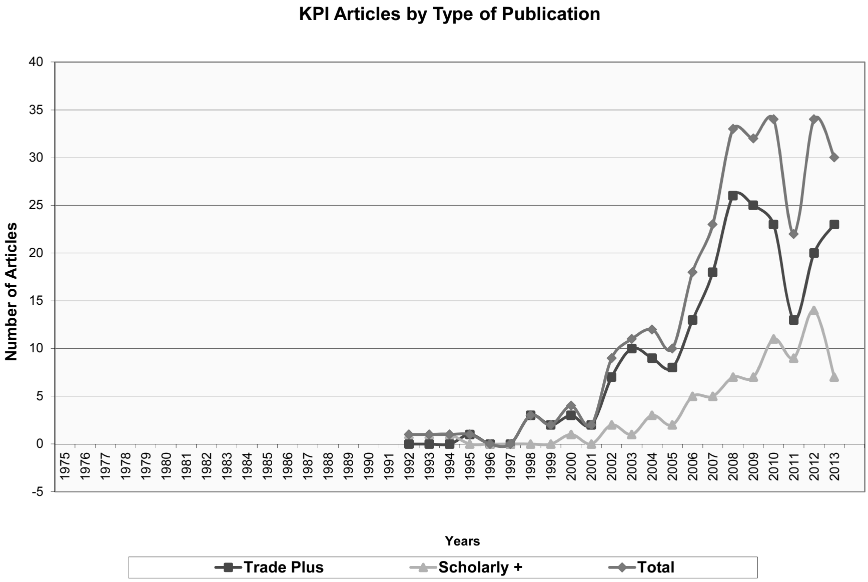

Figure 8D.1. Number of Key Performance Indicator articles.

ment, or enhanced knowledge management. Since it is difficult to improve what is not measured, a KPI program enables a company to measure current performance against goals or benchmarks. It helps to understand an organization's strengths and weaknesses. It also helps managers identify those parts of the operation as most influential in a company's performance.

While a general manager of a division of an international electronics firm, one of the authors introduced a KPI program among the staff members. One of the staff members had always felt the need to have an answer to any question about his operation (quality), whether he had facts or not. After a few weeks using KPIs in his department, he indicated he had never known as much about his department's performance in the past as he did now by using KPIs.

Obstacles

It's all too easy to get carried away during the KPI design process. Defining a large number of indicators is a common mistake, and it takes time, patience, and peer reviews to ensure that the selected KPIs are consolidated to the smallest possible MECE (mutually exclusive, collectively exhaustive) set. It may be useful to start with a longer list and work it down to a smaller one.

The complexity of a dashboard and the effort required to design and implement it will increase exponentially as the number of KPIs increases. KPI design is complex, and gaining consensus on how a KPI will work is time-consuming. The more KPIs selected, the more data sources required. As a result, development will be slower and user acceptance may take longer because the dashboard will likely become unwieldy and hard to understand (Duxbury & Masud, 2009).

While companies spend lots of time deciding which dashboard technologies to use and figuring out how to clean, move and map the necessary data, the least amount of time is often devoted to the most important task. The biggest challenge in dashboard initiatives is not the technology or the data, but determining the measures or KPIs that count. In many cases, the group developing the dashboard will simply take key ratios and statistics from finance reports that have been in use for years and display them graphically on the dashboard. It is highly unlikely that those report items taken together will comprise the correct scorecard for the organization. Painful as it may be, a series of strategic business discussions needs to take place with senior management from across the company to develop the right scorecard. This involves reviewing the company's high-level strategy, short- and long-term goals, and business drivers involved in executing on that strategy. Out of these discussions will come the relevant metrics and KPIs that should then drive the technology and data aspects of the project. Developing the scorecard is obviously not something any single staff function can tackle on its own (Schiff, 2008).

Implementation Steps

Bean and Geraghty (2003) outline the following major stages in implementing a KPI program:

- **Preparing for the trip: timing and team readiness**—A trip is always less painful if well planned and taken at the right time, so you should not begin the KPI journey at the wrong time. When launching the initiative, consider your systems, organization, people and operating environment.
- **Recognizing landmarks: visible milestones**—Reaching major landmarks indicates progress. In implementing KPIs, it is best to begin with a clear idea of all the major steps required, when these need to be achieved and what the end result of each step will be.

- **Celebrating progress: reward/recognition systems**—Having clearly identified milestones is vital for all involved in the KPI implementation. Ensure that rewards and recognition for achievement are equitable, consistent and clearly understood by all involved.
- **Pacing the team: improvements at a healthy, long-term speed**—A low performance business in difficult market conditions should plan a slower implementation than a highly tuned organization in a favorable market. In most cases there is no point in going faster than tools allow; a steady progress is better than one that disrupts the ongoing operation.
- **All implementation programs encounter unexpected hazards**—The key to success is to expect these events, develop contingency plans for them, and do not let them prevent continuing the implementation journey.

Conditions and capabilities of a company are continually changing, so it is important to change KPIs as the need occurs. As markets and products evolve, so does the strategy of the business. These changes must be reflected in the measures and targets of the supply chain. This process of reviewing and refining targets, and the corresponding KPIs, must always consider the direct and indirect changes a new target, or process, may have across the company (Bean & Geraghty, 2003).

Another approach to identifying specific KPIs is described by Griffin (2004): The buzz in IT these days—at least when the topic is business performance management (BPM)—is about key performance indicators (KPIs). The only good KPI is a strategic KPI. By strategic, I mean that any KPI you define for your BPM system should be directly traceable to some component of your overall corporate strategy. There should be a direct link from KPIs to goals, from goals to objectives and from objectives to strategies. Let's take a look at how to develop one.

Consider a company that has developed a strategy to improve its overall operational excellence. While this strategy is certainly desirable, it is hardly quantifiable; therefore, it's far from being a KPI. However, one objective they could establish to execute the strategy could be to improve operational performance in the company's call center. From there, two sample goals to meet that objective could be to improve customer service on calls and to reduce call center costs. These goals are concrete and well on their way to being quantifiable in that you can attach numbers to them, but they are still not metrics that enable a person to monitor performance. Developing those metrics is simple with concrete goals. For example, let's examine the goal to reduce call center costs. The KPI for this goal could be the percentage by which call center costs are reduced over a defined period of time. Once the KPI is defined, it is then possible to decompose that KPI into its various systems of origin, dimensions and calculations. The system that feeds information to the KPI calculation would be in the cost accounting and forecasting package. The dimensions—or ways to sort the information—could be time period, function and business unit. The calculation would be costs incurred in this year's Q1, Q2, etc. versus the costs incurred in the prior year's corresponding time periods.

Future

KPIs are being incorporated into dashboards and scorecards as part of the effort to establish KPIs as a strategic initiative that involves all levels of management.

Electronic dashboards and scorecards are powerful enterprise tools that provide executives with quick insight into business performance. They can be custom-built or based on reporting solutions offered by a number of vendors. Many organizations have come to rely on the key performance indicators (KPIs) found in dashboards. A brief analysis of KPIs often highlights important trends that can significantly impact strategic performance improvement initiatives. Dashboards have matured significantly over the last decade and have evolved into rich solutions possessing comprehensive graphical and tabular reporting capabilities.

However easy they may sound on paper, dashboard implementation projects can be extremely challenging because of complexities that aren't obvious to the inexperienced dashboard development team. Experience shows that such complexities, if not mitigated early in the project, can cause unnecessary delays or even project failure (Duxbury & Masud, 2009).

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CHAPTER 9A

QUICK RESPONSE (QR)

NAME AND BRIEF DEFINITION

Quick Response Program (QRP)—A system of linking final retail sales with production and shipping schedules back through the chain of supply; employs point-of-sale scanning and electronic data interchange, and may use direct shipment from a factory or a retailer (Blackstone, 2013).

Quick Response Manufacturing (QRM). A manufacturing technique based on time-based competition to drive continuous improvement. With its roots in the strategies adopted by the Japanese in the 1980s and developed further by the University of Wisconsin, quick-response manufacturing focuses on the relentless pursuit of lead time reduction. Using manufacturing resources planning for higher-level planning, it often uses a replenishment technique called paired-cell overlapping loops of cards, which combines the best of push and pull strategies. See: paired-cell overlapping loops of cards (Blackstone, 2013).

QR, as the name implies, is designed to reduce the response time from the customer order to delivery of that order. With faster response, companies become more competitive and, as a result, gain market share. The textile and apparel industries are the primary users of this program.

Objectives (Reasons for Adopting Program)

The QR program was developed to help offset the rapid loss of sales to imported products. This was recognized in the mid 1980s and several

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U.S. trade groups attempted to do something about the problem. QR was one such program that attempted to take a revolutionary approach to improving the competitiveness of U.S. apparel firms.

The objective of quick-response (QR) partnerships is to eliminate stock-outs at retail and to increase inventory turns for both retailer and manufacturer. For many manufacturers, QR partnerships have generated new business through sales of additional vendor product lines and have helped build stronger relationships with the retail partner. In a QR partnership, the manufacturer shares information so vendors can involve their forecasting people in talking about projections and how the manufacturing process works (Conley, 1993).

In merchandising, productive use and management of data enables retailers to perform quick response replenishment, continuous merchandise planning, and flow-managed distribution. To get the full benefits of technology changes, retailers should: (1) design their systems for desired results; (2) encourage user participation and accountability; (3) establish defined milestones and measures; (4) secure commitments early to develop a sense of urgency and momentum; and (5) maintain a sustained push from management (Johnson, 1992).

History (Time Line, Reasons Originated, Principal Developers)

Quick Response (QR), which was conceived in a consulting project in 1984–1985 for the Crafted With Pride in USA Council, was projected by Kurt Salmon Associates (KSA) to offer potential savings in the general merchandise retailing and apparel industry of more than $25 billion. Although QR was a simple concept, it was not simple to implement. Therefore, in 1985, the Crafted With Pride in USA Council funded 4 pilot projects to prove QR's viability, to identify the barriers to implementation and to determine how to overcome those barriers. KSA facilitated the first QR pilots with several retailers and manufacturers which all showed improvements. However, retailers began to use different systems for bar coding and electronic data interchange, which became a key obstacle in the implementation. With the implementation of industry standards, benefits of QR far exceeded investment by retailers or by manufacturers. (Apparel Industry, 1994)

Figure 9A.1 shows that the QR program described in this section was popular during the 1988–1997 period, when it was either absorbed into the normal operation of businesses or replaced by the broader concept of CPFR. The recent spike in articles is primarily about what is called "quick response codes," a new marketing tool. "Quick response (QR) codes are a

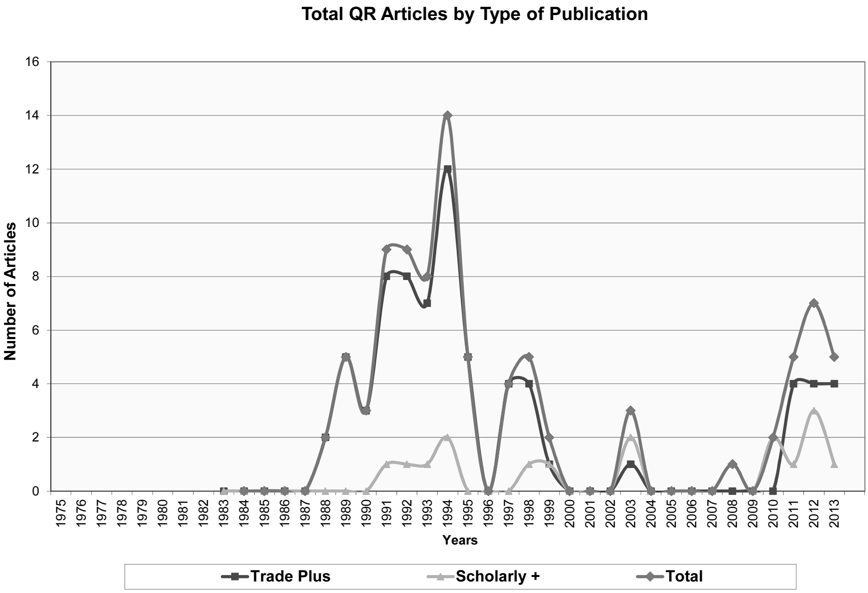

Figure 9A.1. Total number of Quick Response (QR) articles.

marketing tool widely used by top consumer brands to bolster their mobile marketing efforts. QR code use is also making serious inroads into the marketing strategies of professional services firms, and for good reason: according to a recent comScore study, more than 20 million Americans scanned a QR code with a smartphone in just one three-month period last fall" (Alexander, 2012).

The principal elements of QR include:

- Rapid development of sample fabrics and garments
- Computer assisted design (CAD)
- Flexible, short-run spinning, weaving, dyeing and finishing operations
- Just-in-time shipping of fiber and fabric
- Highly engineered manufacturing, including such elements as unit production systems, computerized marking, laser cutting, automated sub-assembly sewing and modular work groups.
- Electronic data interchange
- Standardized bar-coding of fabric and garments
- Pre-ticketing and drop-shipping of garments
- Planned, frequent shipments of garments

- Pulling back open-to-buy dates
- Point-of-sale tracking at retail
- Reducing initial retail orders to less than 50% of requirements
- Flexible merchandise planning
- Continuous re-estimation of customer demand
- Frequent in-season reorders of merchandise with short order-to-delivery times (Hunter, 1990).

One way that QR makes a firm more competitive is by helping it to reduce the length of its pipeline, or its response time in filling a customer order. The adoption of well understood quality management and industrial engineering techniques make it possible to pass goods through the pipeline in one third of the traditional time (Hunter, 1990).

There are four approaches that represent attempts at improving supply chain performance by sharing end-customer demand/sales information backward along the chain. Although they are quasi-"pull"/JIT approaches, none of these incorporate analytic routines that might attempt to optimize supply chain decisions for the various parties involved.

- **Quick response (QR)** which began in the late 1970s as a cooperative effort between several major retailers and suppliers of selected products (mostly textile industry-related), was experimented with in several other industries into the mid-1990s.
- **Continuous replenishment of products (CRP)** is a modification of QR that eliminated the need for replenishment orders and was implemented by Procter & Gamble with a number of major customers.
- With **vendor-managed inventory (VMI)**, the supplier assumes more responsibility and actually manages inventory for the retailer.
- **Efficient consumer response (ECR)** is a grocery-industry-focused variation of QR that involves cooperating partnerships of manufacturers and grocery chains and attempts to achieve significant cost reductions in ways other than solely through improved inventory replenishment (e.g., better allocation of shelf space and fewer wasteful promotions and new product introductions) (Davis & Spekman, 2004).

Expected Benefits (Tangible and Intangible)

The primary objective of the Quick Response program (QR) is to gain additional sales by offering customers faster delivery. The earliest apparel firms increased sales of QR goods in a range between 25% and 35%. However, while QR firms enjoyed 25% to 35% gains, the total national sales of those products increased only a few percent (Anon. Apparel Industry 1994).

Other benefits include reduced markdowns, reduced stock-outs, reduced costs and prices, greater price validity at retail, improved financial performance and increased competitiveness with offshore suppliers (Hunter, 1990).

Major findings indicated that these firms gave vendors incentives to adopt QR and firms having more advanced QR programs perceived fewer problems than those with less advanced programs (Giunipero, 2001).

The quick response process uses real-time, or near-real-time, signals to trigger replenishment responses in the supply chain for manufacturers or retailers. This improves inventory turns, product allocation and replenishment times and helps retailers avoid running out of important stock (Songini, 2001).

In 1985, the Crafted With Pride in USA Council funded four pilot projects to prove that QR was viable, to identify the barriers to implementation and to determine how to overcome those barriers. Kurt Salmon Associates (KSA) facilitated the first QR pilots with the following groups (results shown for each group):

- Wal-Mart/Seminole/Milliken; 47% sales increases with 36% increase in turns and 37% improvement in GMROI
- Belk/Haggar; 31% sales increase with 30% increase in turns
- J. C. Penney/Lanier/Burlington; 25% sales increases with 67% increase in turns and 67% improvement in GMROI
- Dillard's /Lady Arrow; 59% sales increase with 90% increase in turns and 82% improvement in gross margin dollars (Anon. Apparel Industry 1994).

Obstacles to Successful Implementation

One study looked at the relationship of Quick response (QR) to vendor partnering, short-cycle manufacturing, demand-flow manufacturing, virtual integration, reengineering, just-in-time and efficient consumer response as an introduction to the results of a study on which firms are implementing QR and at what stage they are regarding their implementation strategy. The results show that 73% of the responding retailers claimed to be implementing some phase of QR. Implementation is slow, however, with only two of 15 QR components reported to be as much as half-implemented among the retail respondent (Fiorita, May, & Straughn, 1995).

The lack of standards was a key obstacle to implementing QR nationwide. The Voluntary Interindustry Communication Standards Committee (VICS) was formed to develop these standards, and the group retained Kurt Salmon Associates (KSA) to recommend bar coding and EDI standards (Anon, Apparel Industry Magazine 1994).

Traditional EDI systems were expensive and difficult to implement for small companies. In recent years, Internet EDI has become more accessible and has helped to extend quick response systems throughout supply chains.

Problems that have delayed the wide-spread adoption of QR include:

- Naivety—didn't realize the magnitude of the task
- Difficulty in creating "partnerships;" the retailers get the benefits while the suppliers incurred the costs
- Structural issues

- Staggering number of unique SKUs (1.2 to 1.4 million at a department store every four months)
- Overwhelming effect of fashion—shelf lives are decreasing
- Make-up of the pipeline—retailers and textile companies dominate; apparel manufacturers are small
- Technical problems
- Inadequate accuracy of bar codes
- Storage and manipulation of inventory and sales data
- Lack of standards in information transmission (EDI) (Hunter & Valentino, 1995).

Implementation Steps

Kurt Salmon Associates (1997) describes the major elements of a QR program. QR mandates, which touch upon every stage in the supply chain and often call for a company's radical transformation, center on three fundamental processes of an apparel enterprise:

- Product development—from concept to production
- Product sourcing—from the development stage through production and into a ready-to-distribute stage

- Product distribution—servicing customers from order receipt to cash receipt

They provide a checklist for each of these areas:

Product Development

- Line planning and consumer research—analyze point-of-sale data to gain an understanding of their consumer base, determine key sales trends and develop market-right products.
- Concept development—Shop the marketplace, create concept boards, and translate a merchandising-driven line plan into a well-managed product assortment.
- Quick costing—estimate costs to produce a product, and weed out those ideas that will not fit retail price point targets.
- Specifications development—Create specifications, tooling and production processes, computer aided where possible, to increase the speed of developing and efficiency of production.
- Line reviews—To minimize costly late changes in the product development process, conduct line reviews with the manufacturing and merchandising department throughout the earlier steps.

Product Sourcing

- Shorten your own cycles—use partial or complete modular production to reduce work-in-process and resultant manufacturing cycle times.
- Cross boundaries to add speed—streamline the supply chain by limiting the number of suppliers, sharing forecasts and production schedules, and communicate openly.
- Put in the right sourcing mix—be quick but also be responsive. This means not simply fast production but cost-effective production.

Product Distribution

- The Basics—use appropriate technology; include UPC bar coding, EDI, and assorted picking and packing operations.
- New EDI systems—extend existing EDI systems to a wider range of suppliers with Internet EDI, which offers increased accessibility and lower costs, although issues of reliability and confidentiality still are to be resolved.

- EDI with suppliers—reducing lead times with suppliers, especially with foreign contractors, is essential to reducing lead times to customers.
- POS-based Forecasting—use data not only for stock replenishment but also for demand forecasting.
- Joint retailing/vendor forecasting—reduce inventories while maintaining stock for customers. Supplement POS data with knowledge of customers' plans for advertising, promotions and merchandising.
- Cross enterprise forecasting services—take advantage of services that provide almost real-time information on how similar products are selling across the country.
- Integrated production planning and scheduling—use MRP and ERP systems to improve planning and scheduling.
- Replenishment programs—include the basic elements of an effective replenishment program: a POS database; accurate perpetual and located inventory; forecasts and model stocks by account, location and SKU; and replenishment orders.
- Dynamic model stocks—in order to maintain a model stock program, a company must have adequate technology to manage large number of items.
- Attribute replenishment—convert SKUs into product attributes such as color, fabric, and price point to make it possible to replenish a variety of applications.
- DC replenishment—coordinate the replenishment program at both the retail and DC level to minimize inventory without reducing availability.
- Vendor-managed/retail managed inventories—assign inventory management responsibility so that responsibility is clearly defined, there is a partnership level of cooperation and information sharing, and the tools and processes needed are in place.
- Supply chain management—QR has been refined to fit within the supply chain concept (Salmon Associates, 1997).

Future

Quick Response Systems (QRS), as a separate system, has been replaced in the literature by the more comprehensive Collaborative Planning Forecasting Replenishment (CPFR) system. While CPFR systems incorporate many of the features of early QRS, they are still in the formative stages of use.

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CHAPTER 9B

EFFICIENT CONSUMER RESPONSE (ECR)

NAME AND BRIEF DEFINITION

Efficient Consumer Response (ECR)—(1) A grocery industry-based, demand-driven replenishment system that links suppliers to develop a large flow-through distribution network. Information technology is designed to enable suppliers to anticipate demand. Manufacture is initiated based on point-of-sale information. Accurate, instantaneous data are essential to this concept. (2) A management approach that streamlines the supply chain by improving its effectiveness in providing customer service and reducing costs through innovation and technology (Blackstone, 2013).

One of the earliest definitions was: "The ultimate goal of ECR is a responsive, consumer-driven system in which distributors and suppliers work together as business allies to maximize consumer satisfaction and minimize cost. Accurate information and high-quality products flow through a paperless system between the manufacturing line and checkout counter with minimum degradation or interruption both within and between trading partners" (Kurt Salmon, 1993).

A later definition was: "ECR is an attempt to increase the velocity of inventory in the packaged goods industry throughout the supply chain of wholesalers, distributors, and ultimately to consumers. To be successful, the ECR approach will have to eliminate most of the forward buying prac-

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tices of large wholesalers and retailers, which have led to large inventory accumulations in that industry” (Coyle, 1996).

Objectives (Reasons for Adopting Program)

The primary objective of the ECR Executive Committee has been and remains one of education, enlightening prospective participants of the benefits associated with the movement’s four foundations (efficient store assortment, efficient replenishment, efficient promotion, and efficient new product introduction) and the means to achieve these objectives. A multitude of documents was generated through the Committee for the purpose of facilitating ECR implementation to support this educational mission. Despite these efforts, the ECR initiative’s momentum has slowed considerably in the United States (Frankel, 2002).

History (Time Line, Reasons Originated, Principal Developers)

In 1992, several grocery executives formed a voluntary group to conduct a “self examination” of the industry. This group, known as the Efficient Consumer Response Working Group, commissioned a study by Kurt Salmon Associates to identify opportunities for more efficient, improved practices in the grocery industry. The consultants returned in early 1993 with a document claiming that the industry could reduce inventory costs by 10 percent, or $30 billion. Based on the potential for savings and service improvement, the Efficient Consumer Response (ECR) movement quickly gained momentum and enjoyed widespread interest and participation throughout much of the 1990s in the U.S. Other independent movements developed outside of the U.S. and today include formal initiatives in Canada, India, and South Africa as well as throughout Europe. The largest retailers in the U.K have “saved millions of dollars in the late 1990s” as they applied collaborative efforts, based on ECR initiatives, as a way to increase overall efficiency as well as decrease supply chain disruptions.

Figure 9B.1 shows ECR had its maximum popularity during the early 1990s as the number of articles published diminished markedly after about 1998. Most of the articles have been in trade publications as the program has not been of great interest to researchers.

Efficient Consumer Response (ECR) is a phrase introduced at the 1992 yearly conference of the Food Marketing Institute (FMI) in the USA, and is defined as ‘a grocery industry strategy in which retailers, distributors

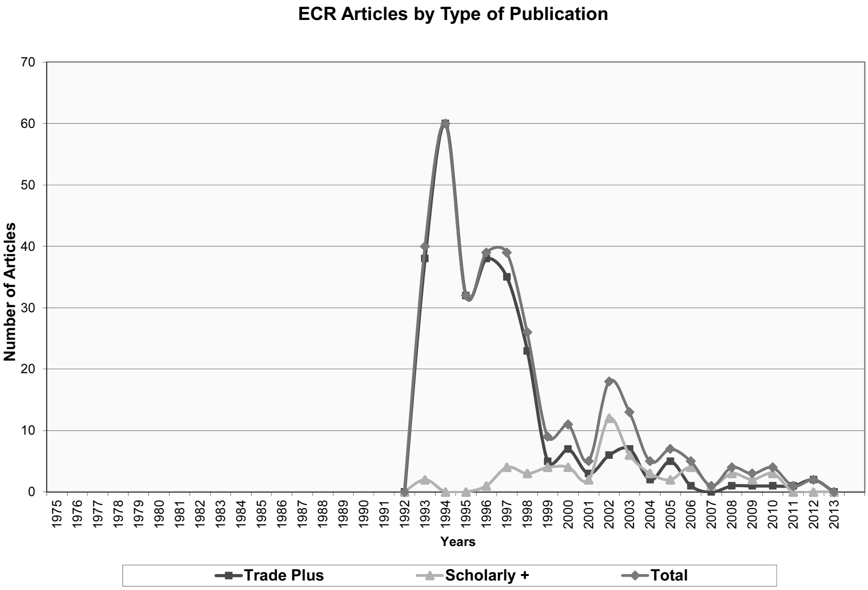

Figure 9B.1. ECR articles by type of publication.

and suppliers work closely together in order to deliver better value to the grocery consumer' (Kurt Salmon Associates, 1993). ECR focuses on the efficiency of the total supply system rather than the efficiency of individual components and aims at reducing total system costs, inventories and physical assets. Emphasis on the application of modern management methods and available technologies makes it possible to achieve a responsive, consumer-driven system, in which customer satisfaction is maximized, costs are minimized, while accurate information and high-quality products flow through a paper-less system between manufacturing line and check-out counter.

ECR is not a system, but a collection of proven methods and tools applied to product categories in an integrated manner across the entire value chain. ECR strives for continuous improvement, as individual companies progressively implement new ECR capabilities and apply them in cooperation with an increasing number of their trading partners. It is a 'strategic initiative' intending to overcome traditional barriers between trading partners and to eliminate internal barriers between functions that result in costs and time but add little or no value to consumers.

The above principles are similar to those in the Quick Response (QR) concept, which was introduced in the mid-80s as a strategy to improve the effectiveness of the supply chain in general merchandise, particularly in soft goods. However, the most fundamental difference between QR (which applies to the apparel industry) and ECR (which mainly refers to the grocery industry) is in the characteristics of the merchandise involved (Pramataris, 1998).

Beyond obvious physical differences in the products, there are critical differences in the value, velocity and variety that characterize merchandise in each industry (Harding, 1995). In surveys conducted both in USA (Hoban, 1993) and in Europe (Kurt Salmon Associates, 1996), it is shown that general awareness of ECR is very high among industry leaders. Most companies see ECR as an inevitable and important development within the grocery industry and plan to be active participants in the process. In Europe, industry leaders both from the retail and manufacturing sectors have taken the initiative to create the ECR Europe Committee. Beginning in 1995, the aim was to increase awareness about ECR and co-ordinate action and pilot project implementation under the ECR umbrella at a European level.

Since then, similar committees with national responsibility have been established in almost every European country. The number of the companies participating in these committees and the importance of the issues undertaken by them constitute a mere evidence of the impact that this new movement, called ECR, is currently having on the grocery industry (Pramataris, Doukids, & Paul, 1997).

The movement's four foundations are:

- Efficient store assortment
- Efficient replenishment
- Efficient promotion
- Efficient new product introduction

Comparison of ECR and QR

Efficient Consumer Response (ECR) makes a great banner for the food industry to march behind into the next century. But as a hard-core distribution strategy—manufacturer to warehouse to store—ECR becomes vague and unfocused. ECR covers a broad range of marketing and operational initiatives, anywhere from efficient store assortments to cross-docking.

- Efficient Consumer Response has been compared to Quick Response, a strategy devised by apparel retailers, mass merchandisers, their suppliers and raw material providers to shorten the pipeline from raw material to checkout counter at the retail store. The motivation was to reduce inventory in the pipeline and respond more rapidly to customer demands. QR spelled out three technologies for implementation:

- Bar codes on all products sold in retail outlets:
- Use of bar code scanners at point-of-sale (checkout counters) in retail outlets;
- Electronic transmission of replacement data from retailer to manufacturer.

Implementation of QR didn't progress very far before two additional factors became apparent:

- Distribution centers would require a higher level of information processing and mechanized material handling to keep inventory flowing through the pipeline.
- To facilitate replenishment and improve the pipeline, vendors and customers would have to form partnerships based on trust—partnering that would go as far as sharing marketing information.

Activities such as store promotions, merchandise mix and manufacturers' product introductions would be impacted one way or another by Quick Response; but the thrust of QR remains clear: Clean out the pipeline. Efficient Consumer Response, on the other hand, suffers from trying to mix merchandising and distribution (as mentioned previously, in practice they're integrated—but a distribution concept must be tightly defined to be effective) (Knill, 1997).

Major Components (Changes Required)

The guiding principles of efficient consumer response are:

1. Constantly focus on providing better value to the grocery consumer: better product, better quality, better assortment, better in-stock service, and better convenience with less cost throughout the total chain.
2. ECR must be driven by committed business leaders determined to achieve the choice to profit from the replacement of the old paradigms of win/lose trading relationships with win/win mutually profitable business alliances.

3. Accurate and timely information must be used to support effective marketing, production, and logistic decisions. This information will flow externally between partners through EDI using UCS standards, and internally it will affect the most productive and efficient use of information in a computer-based system.
4. Product must flow with a maximization of value-adding processes from the end of production/packaging to the consumer's basket so as to ensure the right product is available at the right time.
5. A common and consistent performance measurement and reward system must be used that focuses on the effectiveness of the total system (i.e., better value through reduced costs, lower inventory, and better asset utilization); clearly identifies the potential rewards (i.e., increased revenue and profit); and promotes equitable sharing of those rewards (Freedman, 1993).

Benefits (Tangible and Intangible)

ECR, according to the simplest explanations, looks for efficiencies in four areas: store assortments, replenishment systems, promotions and new product introductions (Sansolo, 1993). Don Bowersox, a professor in the department of marketing and logistics at Michigan State University, offers a simple list of what ECR is and what it is not.

What it is:

- An industrywide initiative for the food channel to revitalize competitiveness with alternative distribution formats.
- A framework to enable and enhance retailer, wholesaler and manufacturer alliances to reduce waste and duplication.
- A strategy to balance the benefits of replenishment and promotion.
- Most of all, a way to increase consumer value through convenient full-service distribution.

What it is not:

- A substitute for managerial leadership and commitment to best practices.
- A cookbook approach offering guaranteed success.
- A commitment to EDLP, including the elimination of promotions.
- A commitment to a single standard procedure.

Bowersox says the challenge of ECR is to make the distribution system leaner to compete for customer loyalty (Sansolo, 1993).

Obstacles

It is widely believed that the ECR movement has failed to live up to expectations because

- Expectations may have been set unrealistically high
- The change process is so complex, including such applications as EDI, Cross-docking, Consolidated multi-vendor distribution, Supply chain integration and Outsourcing to their-party providers
- ECR requires a long-term approach as it incorporates changing traditional behaviors and mindsets, involving 80% people and 20% technology. Some of the requirements include training, reorganization of traditional business structures, overcoming short-term financial pressures, alliance relationships developing among supply chain members, new performance measurement systems and replacing the traditional forward buying (push system) with a "pull" system.
- Difference between industry and individual firm-level initiatives—despite some examples of significant benefits to some companies, not all companies participate (Frankel, 2002).

Hoban (1998) lists the following major barriers to ECR adoption

- Resistance to change by people in the industry
- Implementation costs
- Complexity of the total system
- Availability of appropriate technology
- Revolutionary change in the industry
- Lack of technical compatibility
- Limited management support
- Poor communication
- Lack of openness and trust
- Restricted access to resources
- Limited flexibility

Some explain the disappointment with ECR results from a change process that is so complex. Within any of the four ECR foundations, there are various tools, techniques or programs in which a firm could concentrate to achieve greater efficiency. For example, efficient replenishment could include technological applications (e.g., EDI), cross-docking, consolidated multi-vendor distribution, supply chain integration, and outsourcing to third-party providers, among an array of initiatives. The vast number of options is difficult to comprehend, let alone know where to begin implementation. As an example, just the term "supply chain management" used in conjunction with the ECR umbrella has historically had various definitions and classifications which are confusing for managers and researchers in the field. In spite of this complexity, in order to achieve the massive, reported benefits of $30 billion, large-scale or full implementation of ECR must be assumed a prerequisite. If management picks and chooses only a few areas or tools to implement under the wide ECR umbrella, it is hard to expect benefits to reach their highest potential.

Further, ECR requires a long-term approach as it incorporates changing traditional behaviors and mindsets. The change process is substantial when just some of the necessary elements are considered: training; reorganization of traditional business structures; overcoming short-term financial pressures; alliance relationships developing among supply chain members; and new performance measurement systems. These elements require substantial resource commitments of personnel and time. As an example, forward buying, a traditional push approach to inventory management, conflicts with the suggested pull approach of ECR where there is lack of knowledge about the total costs to the system and short-term financial pressures that encourage overbuying due to price discounts.

Finally, there is a pronounced difference between industry and individual firm-level initiatives. Industries can prescribe initiatives and support them through trade associations, conferences, and publications. In spite of this outreach effort, it is up to individual firms to implement the initiatives. Within the grocery industry, there are certainly individual firms experiencing significant benefits from implementing ECR and its related programs.

While the U.S. ECR movement has lost momentum, the air of cooperation that it engendered throughout the 1990s remains strong in the grocery industry. Collaborative effort is the central theme of ECR as stated succinctly in the mission of "working together [among trading partners] to fulfill consumer wishes better, faster and at less cost" (Frankel, 2002).

Implementation Steps

In one study, most respondents agreed that ECR will be more readily accepted as a customizable set of practices that can be implemented in stages. When viewed as a complete package, ECR appears overwhelming for many companies. Respondents perceived ECR as inevitable and important but did not believe that all was known about the program yet, by them or by the industry (Hoban, 1998).

Efficient consumer response (ECR) seeks to optimize the grocery supply chain, minimizing inventory levels, maintaining product quality and optimizing product availability. The concept relies on partnerships between manufacturers and retailers. Thus, a retail promotion would involve stock replenishment that meets customer demand rather than stockpiling by either manufacturer or retailer. By recognizing that the storage of inventory at a retailer's regional distribution center or a manufacturer's internal warehouse reduces the efficient use of working capital, different solutions are necessary for different products in order to optimize the flow through the total supply chain. Driven by electronic point of sale, the food supply chain under ECR will create automatic reordering to suppliers via the manufacturing plant or distribution center. Implementation of ECR requires three steps that should take place concurrently: 1. Create a climate for change. 2. Select partners. 3. Develop information technology to support ECR (Wood, 1993).

Future

ECR has been an important addition to the management programs list. While it has achieved a degree of success, it is being replaced, at least in some circles, with the Collaborative Planning, Forecasting, and Scheduling (CPFR) program, which offers greater collaboration among supply chain participants. CPFR is covered as a separate program.

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CHAPTER 9C

VENDOR MANAGED INVENTORY (VMI)

NAME AND BRIEF DEFINITION

Vendor Managed Inventory (VMI)—A means of optimizing supply chain performance in which the supplier has access to the customer's inventory data and is responsible for maintaining the inventory level required by the customer. This activity is accomplished by a process in which resupply is done by the vendor through regularly scheduled reviews of the on-site inventory. The on-site inventory is counted, damaged or outdated goods are removed, and the inventory is restocked to predefined levels. The vendor obtains a receipt for the restocked inventory and accordingly invoices the customer. See: continuous replenishment (Blackstone, 2013).

Continuous replenishment—A process by which a supplier is notified daily of actual sales or warehouse shipments and commits to replenishing these sales (by size, color, and so on) without stockouts and without receiving replenishment orders. The result is a lowering of associated costs and an improvement in inventory turnover. See: vendor-managed inventory (Blackstone, 2013).

Objectives (Reasons for Adopting Program)

The primary objectives of VMI are to improve customer service by reducing or eliminating stockouts, and to reduce operating costs by

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reducing inventory levels along the supply chain. This is accomplished when the customer makes relevant information available to the vendor, such as sales and inventory levels. The vendor has the responsibility, and authority, to replenish the customer's stock according to their mutually agreed-to inventory control principles and objectives (Cachon & Fisher, 1997; Kaipia, Holström, & Hellström, 2007; Waller et al., 1999). In addition, since the vendor is free to choose the timing of the replenishment shipments, it can further dampen demand peaks, for example, by delaying noncritical replenishments (Kaipia et al., 2007; Smaros 2003).

History (Time Line, Reasons Originated, Principal Developers)

VMI is one of several automated replenishment programs started in the late 1980s or early 1990s. Other similar programs include continuous replenishment planning (CRP); quick response systems (QRS), initiated in the apparel industry; and efficient consumer response (ECR), for the grocery industry. A more recent addition to the group is collaborative planning, forecasting and replenishment (CPFR). These programs were all designed to improve the flow of goods from the manufacturer to the distribution centers and on to the retailers. Often driven by retailers, such as Wal-Mart, who wanted to increase their inventory turns and reduce stockouts, they became a part of the effort to improve the supply chains.

Figure 9C.1 shows that VMI has precipitated an increasing number of published articles in recent years, and appears to be still in the growth stage of the publication life cycle, although there has been a decline in the past couple of years. Although newly-packaged, the authors know, from personal experience, that VMI was preceded by marketing concepts known as rack jobbing or service merchandising several decades ago. These approaches were used actively in health and beauty aids merchandise.

Expected Benefits (Tangible and Intangible)

In most cases, the major benefits have been improved customer service for the retailer and reduced inventory costs along the supply chain. Angulo (2004) identified a more exhaustive list of benefits, such as:

- Reduced costs due to better resource utilization for production and transportation

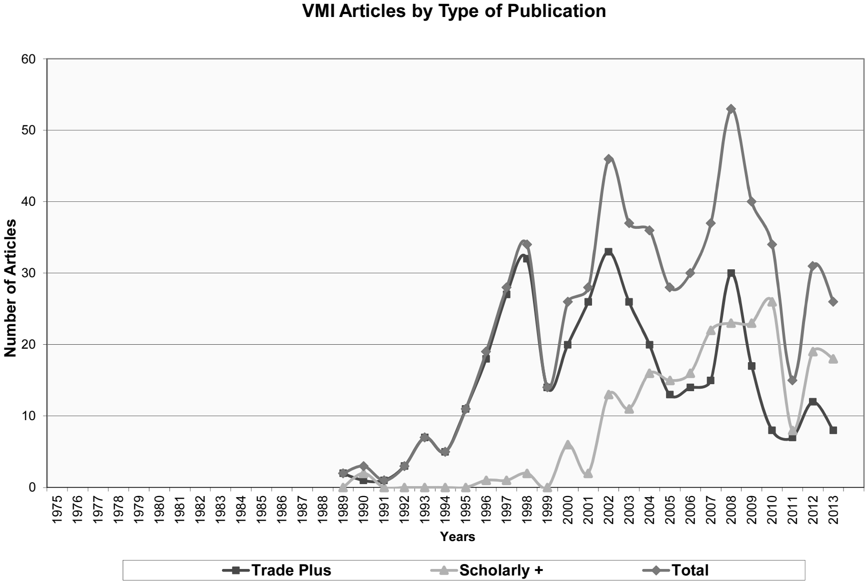

Figure 9C.1. Total number of VMI articles.

- Improved service levels due to better coordination of replenishment orders
- Reduced lead times and increased inventory turns
- Reduced inventory stockouts by increasing inventory visibility
- Higher selling space productivity obtained by optimizing inventory
- Control of the "bullwhip effect", i.e. the distortion and amplification of demand information as it moves up the supply chain,
- Solidified customer loyalty through development of a long-term trustworthy relationship,
- Improvement of overall information system capabilities.

Smaros et al. (2003) studied how manufacturing companies can benefit even from a partial increase in demand visibility. They looked at a situation where a manufacturer loads its production with a combination of order data from non--VMI customers and sell-through data from a varying number of VMI customers. Using simulation, they found how the manufacturer's benefit, measured as reduced variability of its production load, increases as the number of customers increases.

During the last few years, following the advent of enabling technologies, the role of information sharing as a means of reducing bullwhip in the supply chain has received great interest.

Chen et at. (2000) used mathematical modeling to examine the effect of information sharing, forecasting and lead times on the bullwhip effect, and concluded that although access to customer demand information does not completely remove the problem of variability amplification it can significantly reduce it.

Cachon and Fisher (2000) have also, based on a simulation study, concluded that for stationary demand the benefits of more frequent ordering and timely processing outweigh the benefits of information sharing.

VMI can help in reducing costs, reducing delivery times and increasing flexibility in responding to customers. While it does not focus directly on product quality, reduced inventories usually require less variability in product quality, thereby necessitating quality improvements. Improved customer service is a measure of service quality.

Obstacles

The major costs in VMI appear to be in developing the information systems necessary to link with customers and suppliers. While there are expenses associated with the commitment of internal resources to planning and managing the VMI system, or the use of consultants to supplement internal resources, they vary widely and must be decided for each situation.

A cost-benefit analysis should consider both tangible and intangible costs. Most of the reported cases point out that there are benefits for both the supplier and the customer in the form of reduced inventories and stockouts.

While many benefits have been identified in the literature, there are a number of challenges that exist in practice that may potentially reduce benefits. Two of the challenges of information sharing include inaccurate inventory information and delays in replenishment decisions. One study examined the effects of using inaccurate inventory information and delays in replenishment decisions on inventory levels and fill rates. Delays in replenishment decisions can be due to delays in information transmission, information systems updating, or simply managerial delay (Daugherty, Myers, & Autry, 1999).

Additional research by Smaros, Lehtonen, Appelqvist and Holstrom (2003) found that a major challenge for manufacturing companies is that usually, only part of their customer base is involved in VMI, which requires manufacturers to set up their operations in a way that efficiently serves both VMI and non-VMI customers simultaneously. However, research has provided only little support for companies struggling with limited visibility and a heterogeneous customer base.

Cottrill (1997) points out, in VMI, suppliers assume the responsibility for managing inventories at customer locations through the use of highly automated electronic messaging systems. Vendors and customers exchange sales and demand data, and use the information to plan and implement product replenishment and sales strategies. Typically, vendors have borne most of the development and implementation costs. If successful, the increased sales that result from VMI benefit all participants. While technology such as electronic data interchange (EDI) is a vital component of VMI, it is more important from a strategic viewpoint that companies redefine their business relationships.

Lapide (2001) suggests that the main reason why manufacturing companies have failed to benefit from VMI is that they have only implemented the execution part of VMI (i.e., the sales and distribution transactions). He claims that the companies have not managed to link the demand information, i.e. the customer sell-through information available through VMI to their production planning and inventory control systems. Consequently, one can conclude that linking demand information to supply chain planning seems to be of critical importance to benefiting from visibility efforts such as VMI (Smaros, 2003).

Implementation

The essential ingredient of a VMI program is the willingness to communicate between customer and supplier, such as a manufacturer and a distributor. This involves a willingness to share information, some of it heretofore considered confidential. Obviously, this requires trust between the participants.

In addition to a willingness to share information, there must be a means of sharing the information. This usually means some form of electronic communications capability and compatibility, a requirement not always easily fulfilled. To date, the means has usually involved electronic data interchange (EDI), which we will discuss more fully later.

If companies are both willing and able to share information, they must have reliable data; especially demand data at the consumer (retail) level. Reliable means both accurate and timely. It is logical that the greater the variability in accuracy or timeliness, the lower the expectations for improvement.

With accurate and timely information, demand forecasts become more attainable. While extending past demand history will be more meaningful, the forecasts can be further improved with inputs from customers about planned promotions or other events that will affect their demand.

With a more reliable demand forecast, manufacturers can develop more effective and efficient production plans. They will do a better job of meeting customer due dates and, at the same time, reduce their own work-in-process inventories. With improved performance, manufacturers can realistically expect more business from their customers.

Before the vendor can begin, they must obtain their customers' inventory stocking strategies. This involves deciding on such issues as A, B, C classification criteria, safety stock guidelines, and targets for fill rates and inventory turns. These criteria should be reviewed and adjusted as conditions change or improved information becomes available.

With VMI, suppliers/vendors initiate the stock replenishment orders, based on the demand forecasts and feedback from their customers' inventory status reports. This relieves the customer of preparing purchase orders and provides the vendor with greater flexibility in how to schedule the delivery of the orders.

Techniques or Technologies Used (Quantitative or Qualitative)

The technology of choice to provide the communication capability is EDI. That will probably change in the future, as the internet becomes a more popular communications medium. The use of EDI requires the use of industry-wide information processing standards.

Daugherty et al. (1999) studied some of the information systems capabilities considered relevant to automatic replenishment programs. They included two major groups—information timeliness and information compatibility. Information timeliness included such factors as timeliness, accuracy and availability of information. Information compatibility included formatting and connectivity, both internal and external, considerations.

Companies continue to use existing forecasting techniques. The improvement in forecasts results from more timely and more accurate information.

Case Histories

Kozak believes that this level of cooperation is essential, and requires senior management support. One problem with VMI is that it for it to function properly all parties must be able to communicate using the same protocols. This has proved to be a major drawback of EDI-based systems, in that companies often use different protocols, making it difficult to establish a common language for the exchange of electronic information. One of the main reasons why the electrical industry has been active in VMI is that it has adopted industry-wide communications standards (Cottrill, 1997).

Smaros (2003) identified several case studies that indicate the benefits of VMI in the area of production planning and inventory control can be significant. Kaipia et al. (2002) demonstrated that implementing VMI can enable substantial inventory reductions as well as an opportunity to shift from make-to-stock to make-to-order production. Success stories from the industry demonstrate the potential of VMI in practice; companies have reported inventory reductions, improved customer service, and reduced obsolescence as the results of VMI adoption (Kaipia et al., 2007).

Related Programs and Their Evolution

As described earlier, the programs most closely related to VMI are other automatic replenishment programs, such as Quick Response (QR) in apparel, Efficient Consumer Response (ECR) in groceries, and Continuous Planning, Forecasting and Replenishment (CPFR). Each of these programs is described more fully in other sections of this book.

Integrated and automated VMI has found a niche in the retail and automotive industries. VMI actually requires integration of the supplier's production information with the client's inventory data. Coupling that with historical demand data and forecasting modules allows the vendors to keep within the client's inventory parameters. For the client, VMI improves fill rates while decreasing inventory levels. In other words, a good VMI system enables the client to have enough inventory to meet demand, but not incur excess inventory costs (Bury, 2004).

Future

While VMI programs have been successful, they may not be the answer for all companies. Niranjan et al. (2011) developed a list of preconditions for VMI, or those conditions that affect an organization's readiness for VMI. They include:

- **Company**—stable growth; high transaction costs; good information and communication system; willingness to share information; and purchasing is not a core competency.

- **Product**—Standardized products; repeating products; standard product identification; low demand variance; and demand is forecasted and stock levels are monitored.
- **Supplier**—Supply chain trust/long-term relationships; advantages evident to both supplier/customer; key suppliers constitute a high percentage of purchase orders; suppliers are willing to cooperate; and integrated information system.

As the list suggests, not all companies are ready for VMI.

VMI programs will continue to flourish, although there will probably be a number of similar programs without the VMI designation. The idea of having the supplier help manage their customers' inventories will become a more common requirement as large retail customers exert more pressure on suppliers. It may be in the form of consignment merchandise where the customer doesn't pay for the goods until they sell them.

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CHAPTER 9D

COLLABORATIVE PLANNING, FORECASTING AND REPLENISHMENT (CPFR)

NAME AND BRIEF DEFINITION

Collaborative Planning, Forecasting, and Replenishment (CPFR)—(1) A collaboration process whereby supply chain trading partners can jointly plan key supply chain activities from production and delivery of raw materials to production and delivery of final products to end customers. Collaboration encompasses business planning, sales forecasting, and all operations required to replenish raw materials and finished goods. (2) A process philosophy for facilitating collaborative communications. CPFR is considered a standard, endorsed by the Voluntary Interindustry Commerce Standards. Syn: collaborative planning (Blackstone, 2013).

Objectives (Reasons for Adopting Program)

The primary objectives are improved customer service and reduced costs. Improved customer service results from reduced stockouts at both the supplier and customer. Reduced costs result primarily from reduced inventory levels and reduced excess inventories.

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 295–302
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History (Time Line, Reasons Originated, Principal Developers)

The first robust initiative created to enable integration in the supply chain dates back to 1992, when 14 trade association sponsors, including Grocery Manufacturers of America and Food Marketing Institute, created a group named Efficient Consumer Response Movement, or ECR, with the purpose of leading an unprecedented transformation in business practices. Late in 1992, the ECR Movement issued a report suggesting optimum business practice for the management of the supply chain (Kurt Salmon Associates, 1993). Supply chain benefits could be achieved by excelling in four core strategies: efficient promotions, efficient replenishment, efficient store assortment and efficient product introductions. For a more detailed explanation see Kurt Salmon Associates (1993). The report proposed, for the first time, the driving need to develop a trust-based relationship between manufacturers and retailers (including suppliers and customers in general), with the sharing of strategic information in order to optimize overall supply chain results. Having this requirement outlined, the various sectors of the industry began to develop a number of techniques to make the ECR promise a reality.

While ECR brings many potential benefits to both suppliers and retailers in terms of efficiency improvements, the biggest opportunity it presents is to enable real supply chain collaboration. By sharing information, it enables supply chains to become demand driven and in so doing, to deliver enhanced customer value. Therefore, ECR can be seen as an enabler of the drive towards an integrated supply chain.

A number of other collaborative-based initiatives are worthy of mention. Vendor-managed Inventory (VMI) and continuous replenishment (CR) are coexisting supply chain management techniques that, in different ways, try to deliver the promised benefits of ECR.

Two of the first companies to put the theory into practice were Procter & Gamble and Wal-Mart. This partnership gave impulse to the diffusion of VMI within the grocery sector, at a pace quicker than has been observed in other sectors (see also Peck, 1998).

Many companies predicted that VMI, if properly managed, would lead them to excellence in the four areas as listed above. Although a few companies still maintain the traditional VMI-based relationship with their trading partners, many others have abandoned the practice and migrated to other supply chain management techniques. The major weakness of VMI lies in the insufficient visibility of the whole supply chain (Barratt & Oliveira, 2001).

VMI is not going to be the only way, not even the predominant way, but that VMI will be one of many methods employed in the search for greater supply chain efficiencies. Another of these many methods is the Continuous Replenishment Program (CRP, or simply CR), which emerged as a business practice in early 1990s attempting to address and improve ECR's four core strategies (Andraski, 1994).

Figure 9D.1 shows the number of CPFR articles. The program was recognized as a successor to earlier response programs in the late 1990s, peaked about 2002 and has declined steadily since, although there is a lingering interest by academics in studying this program.

In terms of supply chain management, CR reveals stock levels in retailers' stores. For the first time, POS data is used to generate a sales forecast. The inventory policy is then based on the sales forecast, built from historical demand data and no longer purely based on the variations of inventory levels at the customers' main stock-holding facility. A process which is usually owned by the supplier, the CR practice allows the management of the supply chain at different levels (such as by product or by store), according to business needs. Some customers have made their POS data available to their suppliers who usually consolidate this information as a monthly pattern in comparison with the previous year and, based on that, try to predict future sales.

At the same time CR represents an innovation in relation to VMI practices. The process of creating the sales pattern and then predicting future

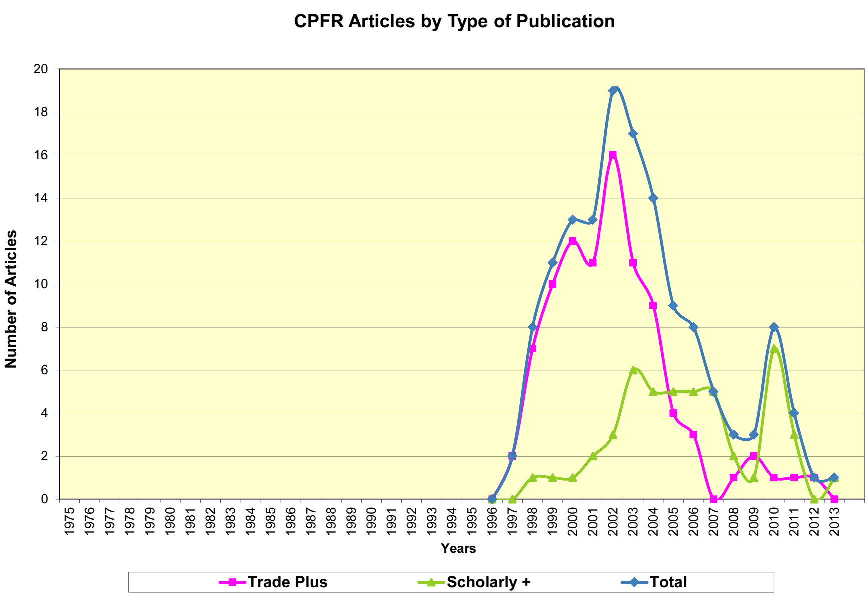

Figure 9D.1. Number of CPFR articles.

events is also CR's major weakness. According to Joe Andraski, vice-president of customer marketing operations at Nabisco, "CR is usually done by a manufacturer, based on algorithms and history, but its ultimate success is dependent on the skill of the continuous replenishment analyst working with a particular account, whereas real forecasts need to come from the retailers" (Andraski, 1994).

Ralph Drayer, vice-president for ECR at Procter & Gamble (cited in Andraski, 1994), suggests that there is still a lot of excess inventory in the pipeline, even after CR. Although CR has provided a better approach to replenishment and product assortment processes, there is still a long way to go. In relation to promotion and new product introduction processes, there is still a clear gap between CR practices and ECR promises (Barratt, 2001).

In its short existence, CPFR has evolved considerably. Initially referred to as collaborative forecasting, the concept represented an exchange of early demand expectations between trading partners. It was subsequently referred to as collaborative forecasting and replenishment (CFAR) to denote the collaborative forecasting and replenishment objectives of the approach between trading partner relationships downstream from OEMs. As it has evolved today, CPFR emphasizes coordinating the activities of production and purchase planning, demand forecasting and inventory replenishment through collaboration among all supply chain trading partners (Fliedner, 2003)

The first CPFR pilot started in 1996 when Wal-Mart Stores collaborated with supplier Warner-Lambert, focusing on its Listerine product line. In conducting the pilot, Wal-Mart and Warner-Lambert independently calculated the demand they expected six months into the future. They exchanged forecast numbers over the Internet, using special CPFR software (Schenck, 1998a).

The pilot proved successful. Sales of Listerine products increased, in-stock rates were significantly higher, fill rates were at or near the points they were planned to be and inventories were reduced. Benefits accrued to manufacturer and retailer alike. The key lessons learned are that collaboration should be viewed as an iterative process, and that effective collaboration can occur at any stage of a product lifecycle.

Following a successful pilot with Warner-Lambert, Wal-Mart contacted the Voluntary Inter-industry Commerce Standards (VICS) organization about establishing standards for CPFR. Taking the initiative to VICS was a critical step towards making CPFR successful, because the initiative needs a critical mass of retailers and manufacturers to be successful. Other major organizations such as Kmart, Procter & Gamble, Ernst and Young, Goody's Family Clothing, JC Penny, Lucent, Sara Lee

Corp., the Uniform Code Council, Nabisco and others are now supporting the initiative.

Expected Benefits (Tangible and Intangible)

The early exchange of information between trading partners provides for reliable, longer term future views of demand in the supply chain. The forward visibility based upon information sharing leads to a variety of benefits within supply chain partnerships. Because CPFR is relatively new, data to evaluate its impact empirically are not readily available. Anecdotal evidence provided from the results of several pilot programs highlight benefits, which are:
Retailer benefits:

- Increased sales;
- Higher service levels (in-stock levels);
- Faster order response times;
- Lower product inventories, obsolescence, deterioration.

Manufacturer benefits:

- Increased sales;
- Higher order fill rates;
- Lower product inventories;
- Faster cycle times;
- Reduced capacity requirements.

Shared supply chain benefits:

- Direct material flows (reduced number of stocking points);
- Improved forecast accuracy; lower system expenses (Fliedner 2003).

In 2002, the WorldWide Retail Exchange (WWRE), a business-to-business Internet exchange for retailers, conducted a Collaborative Planning, Forecasting and Replenishment (CPFR) test involving 480 SKUs in general merchandise, food, drug, electronics and apparel in 12 trading partnerships. The test, which deployed a collaborative planning module powered by i2 Technologies, produced impressive results. According to the WWRE, the following results were realized.

- Forecast accuracy increased 25%. By collaborating on sales, order and promotional forecasts, participants developed a mutually agreed upon forecast based on the best data available to both parties. These improved joint forecasts formed the basis for other supply chain efficiencies such as service level improvements, inventory reductions and increased sales.
- Excess inventory reduced 32%. Visibility and confidence in the collaborative forecast enabled the trading partners to more closely match replenishment plans to consumer demand, reducing costly safety stock.
- Lead time reduced 25%. Trading partners worked together to jointly establish business goals. Existing business processes were then examined to determine methods to meet these goals. By jointly developing a more efficient process, and better aligning supply chains, participants reduced delivery time.
- In-stock levels improved 10%. Avoiding empty shelves resulted in increased sales levels as well as long-term gains such as increased customer satisfaction and loyalty. Shared plans, better demand visibility and more reliable forecasts improved product availability (Harrington, 2003).

In general, CPFR makes it possible to match supply more closely with demand, thereby reducing stockouts and lost sales while maintaining low levels of inventory which reduces the need for clearance sales and loss from obsolescence or damage.

Barriers to Acceptance

As with most new corporate initiatives, there is skepticism and resistance to change. Several anticipated and actual obstacles to implementation have been anecdotally reported in the literature and are discussed below. These are:

- Lack of trust in sharing sensitive information;
- Lack of internal forecast collaboration;
- Availability and cost of technology/ expertise;
- Fragmented information sharing standards;
- Aggregation concerns (number of forecasts and frequency of generation); fear of collusion (Fliedner, 2003).

Implementation Approach

Drilling down to a more granular level, VICS has reduced CPFR to eight basic tasks that support the overall plan-ship-sell-replenish lifecycle of a consumer goods item. These tasks are shown in Table 9D.1.

Future

The number of articles published specifically about CPFR has declined in recent years, indicating some reduced interest in it as a specific improvement program. However, the concept of collaboration between customers and suppliers is of increasing interest. It has expanded into the more general form of supply chain integration, with its emphasis on collaboration among all supply chain participants.

Larry Lapide (2010), active in the development of CPFR, reports that CPFR "never became the big deal we all thought it would be when it was first introduced." However, he believes that CPFR was instrumental in showing that collaboration along the supply chain could improve planning and operations.

Table 9D.1. Tasks Involved in Implementing CPFR

Retailer Tasks	*Collaboration Tasks*	*Manufacturer Tasks*
Strategy & Planning		
Vendor Management	Collaboration Arrangement	Account Planning
Category Management	Joint Business Plan	Market Planning
Demand & Supply Management		
POS Forecasting	Sales Forecasting	Market Data Analysis
Replenishment Planning	Order Planning/Forecasting	Demand Planning
Execution		
Buying/Re-buying	Order Generation	Production & Supply Planning
Logistics/Distribution	Order Fulfillment	Logistics/Distribution
Analysis		
Store Execution	Exception Management	Execution Monitoring
Supplier Scorecard	Performance Assessment	Customer Scorecard

Source: Adapted from http://www.gs1us.org/DesktopModules/Bring2mind/DMX/Download.aspx?Command=Core_Download&EntryId=631&PortalId=0&TabId=785. Used with permission.

Ron Burnette (2010) also believes that CPFR, as a concept, has been integrated into many companies as part of their efforts to integrate their supply chains. CPFR has changed from a rigid nine-step process to a more flexible model which enables companies to focus on the issues most important to them. One area of increasing interest to many companies is the blending of CPFR principles with Sales and Operations Planning (S&OP). As Burnette points out, “The importance of collaboration is well understood and it is now one of the key initiatives of many supply chain organizations around the world.”

CPFR is a good example of a specific management program whose key components have been assimilated into everyday practice at successful companies.

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CHAPTER 10A

MANUFACTURING FLEXIBILITY

NAME AND BRIEF DEFINITION

Flexibility—(1) The ability of the manufacturing system to respond quickly, in terms of range and time, to external or internal changes. Six different categories of flexibility can be considered: mix flexibility, design changeover flexibility, modification flexibility, volume flexibility, rerouting flexibility, and material flexibility (see each term for a more detailed discussion). In addition, flexibility involves concerns of product flexibility. Flexibility can be useful in coping with various types of uncertainty (regarding mix, volume, and so on). (2) The ability of a supply chain to mitigate, or neutralize, the risks of demand forecast variability, supply continuity variability, cycle time plus lead-time uncertainty, and transit time plus customs-clearance time uncertainty during periods of increasing or diminishing volume.

- Mix flexibility—The ability to handle a wide range of products or variants by using equipment that has short setup times.
- Design changeover flexibility—The capability of the existing production system to accommodate and introduce a large variety of major design changes quickly.
- Modification flexibility—The capability of the transformation process to quickly implement minor product design changes.
- Volume flexibility—The ability of the transformation process to quickly accommodate large variations in production levels.

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- Rerouting flexibility—Accommodating unavailability of equipment by quickly and easily using alternate machines in the processing sequence.
- Material flexibility—the ability of the transformation process to handle unexpected variations in material inputs (Blackstone, 2013).

Although the types of flexibility required of supply chains parallels those for individual manufacturers, they are more complex because of the interactions among supply chain partners. "The multi-dimensional nature of manufacturing flexibility indicates supply chain organizations may require different types and levels of flexibility based on their strategic objectives. As a result, manufacturing flexibility is not generic and cannot simply be treated as a commodity that could be bought off-the-shelf and immediately applied; rather, it should be justified, planned, and managed carefully in order for its potential benefits to be fully realized (Gustavsson, 1984; Yang et al., 2003)," from (Kumar, 2006).

While the distinction between flexibility and agility is at times blurred, there is agreement that flexibility is a necessary capability for agility. Agility is the ability to produce and market successfully a broad range of low cost, high quality products with short lead times in varying lot sizes, which provide enhanced value to individual customers through customization (Vokurka & Fliedner, 1998).

Ferdows and DeMeyer (1990) introduced a progressive model for companies to follow. Quality should be established first, then dependability, then flexibility and finally cost benefits will accrue. Later studies extended this model to show a progression from quality to dependability, to flexibility, to agility, to cost efficiency (Vokurka & Fliedner, 1998). Part of their logic confronts this paradox—Cost reduction efforts may not lead to quality improvements; however, quality improvements often lead to cost reductions.

Another study suggests agility is flexibility plus customization. Mass customization focuses on product customization; agility enables a company to respond to other changes, such as government regulation or changes in technology (Krishnamurthy & Yauch, 2007).

Objectives (Reasons for Adopting Program)

Johnson (2009) lists the following reasons why flexibility and agility are required:

- Global competition is intensifying
- Mass markets are fragmenting into niche markets.

Table 10A. Comparison of Flexibility and Agility Characteristics

Flexibility	*Agility*
• Predictable variations	• Unexpected changes
• Tactical implications	• Strategic implications
• Production-oriented	• Customer-oriented
• Product variety	• Product customization
• Not necessarily global	• Global perspective
• Technology primarily	• Technology, infrastructure, employees
• Programmable, proactive	• Responsive, reactive
• Incremental change	• Disruptive change
• Controlled demand	• Unpredictable demand
• Established relationships	• Virtual organizations
• Cooperative exchanges	• Collaborative relationships
• Structured decision-making	• Empowered decision-making
• Closed system environment	• Open system environment
• Anticipate what the customer wants	• Make what the customer wants
• Assemble-to-order or make-to-stock	• Make-to-order or engineer-to-order
• Organization centralized, hierarchical, bureaucratic	• Organization decentralized, flexible, organic

- Cooperation among companies is becoming necessary, even those in direct competition.
- Customers expect low volume, high quality, custom products.
- Very short product life cycles, development times, and production lead times are required.
- Customers want to be treated as individuals.
- The frequency of unexpected events is increasing; there is a greater need for agility.

Global competition means competition can come from more places. Increased technology can increase flexibility and agility, but it also increases capital investment requirements. As a result of globalization and increased outsourcing, supply chains are becoming increasingly complex (Crandall, 2009).

Does it really matter if a business is agile, or even flexible? Peter Drucker warns "uncertainty—in the economy, society, politics—has become so great as to render futile, if not counterproductive, the kind of planning most companies still practice: forecasting based on probabilities." (Drucker, 1992). Thomas Friedman, in both his recent books *The World is Flat* and *Hot, Flat and Crowded*, warns of the need for businesses to become more responsive to increased global competition (Friedman 2006; 2008).

Customer demand is the primary driver for companies to become flexible and agile. “Widespread discontinuous change makes unpredictability a given. Uncertainty is not a passing symptom, but a fact of economic life in the information era. Given the fundamental differences separating the Industrial Age economy from the Information Age economy, only a fundamentally different kind of business organization will suffice. Continuously discontinuous change demands a new business model. The dominant large corporations of the twenty-first century will succeed only by embracing new concepts, not by better executing the old ones” (Haeckel, 1999).

Haeckel recommends businesses move from a “Make-and-sell” orientation to a “Sense-and-Respond” position. In Make-and-Sell, the assumption is predictable change with a goal of becoming an efficient enterprise. In Sense-and-Respond, the assumption is unpredictable change and the goal is to become an adaptive (agile) enterprise.

In his book *The Innovator’s Dilemma* Clayton Christensen (2003) describes how many well-managed companies fail to handle disruptive technologies—new technologies that spawn new companies to replace established companies. He claims, “Amid all the uncertainty surrounding disruptive technologies, managers can always count on one anchor: *Expert’s forecasts will always be wrong*. It is simply impossible to predict with any useful degree of precision how disruptive products will be used or how large their markets will be. An important corollary is that, because markets for disruptive technologies are unpredictable, companies’ initial strategies for entering these markets will generally be wrong.” He strongly supports the need for agility as uncertainty and unpredictability increase.

History (Time Line, Reasons Originated, Principal Developers)

Manufacturing managers have been trying to build flexibility into their processes since the late 1970s. They recognized the marketplace was changing as foreign competition increased when countries in Europe and Japan rebuilt their industrial capacity following World War II. This increase in competition brought with it increased product variety, partially in response to changing consumer tastes.

Early efforts in manufacturing were reflected in flexible manufacturing systems (FMS), roughly coinciding with growth of the computer integrated manufacturing (CIM) concept. Figure 1 shows the number of articles published, using the key words “flexibility” and “production management.” We attempted to eliminate references to Flexible Manufacturing Systems (FMS). Trade publications led the number of articles early;

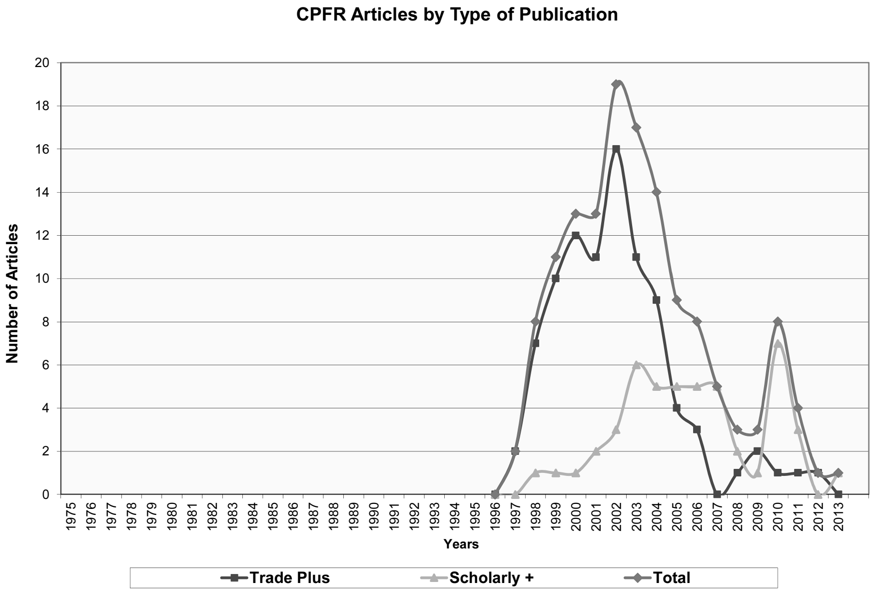

Figure 10A.1. Total number of Flexible Manufacturing articles

however, scholarly articles have also been popular in recent years. The desire for flexibility was recognition of the eventual need for mass customization, a program described as a separate program in this book.

Expected Benefits (Tangible and Intangible)

Advocates of flexibility held out the hope for a number of benefits, including:

- Lower production costs, especially in reduced setup and changeover times
- Closer matching of production product mix with demand product mix
- Reduced work-in-process inventories
- Increased customer satisfaction with increased product choices
- Capability to use new materials—stronger, lighter, more durable
- Increased capacity utilization—auto assembly plants could make more than one model

Barriers to Acceptance

Gerwin (1993) points out some caveats to increasing flexibility

- Increasing product variety (mix flexibility) leads to complexity and confusion that raises overhead costs (Skinner, 1985).
- By the time the current product is out of date, developments in process technology will make existing flexible equipment obsolete. Its changeover capability will probably not be utilized (Sakurai, 1990).
- Modification flexibility reduces pressures to get designs right the first time leading to unnecessary engineering change orders.
- Investment in excess capacity, empty floor space, and slack time in the production schedule is necessary to have volume flexibility.
- Rerouting flexibility, by creating alternative production paths, discourages efforts to eliminate machine breakdowns.
- Material flexibility reduces pressures on upstream activities to eliminate quality problems (Nevins et al., 1989).

Implementation Approach

How do companies achieve flexibility and beyond to agility? There are no neat six-step formulas to success. Most of the recommendations of how to proceed are in the form of general guidelines. The Iacocca Institute report coined the term “agile manufacturing” and states agility is required to respond to the new competitive environment that is emerging. Acquiring that agility requires the integration of flexible technologies with a highly skilled, knowledgeable, motivated and empowered workforce, within organizational and management structures that stimulate cooperation both within and between firms (Iacocca Institute, 1991).

Paul Kidd echoes the Iacocca report in his book. “Agile manufacturing can be considered as a structure within which every company can develop its own business strategies and products. The structure is supported by three primary resources: innovative management structures and organization, a skill base of knowledgeable and empowered people and flexible and intelligent technologies. Agility is achieved through the integration of these three resources into a coordinated, interdependent system” (Kidd, 1994).

In essence, there is a need to acquire agility to do things without knowing what will be required; consequently, information, and knowledge management will become increasingly important. Technology is essential but it must be supported with a flexible infrastructure and a willing group of knowledgeable and motivated employees.

Future

Focused, or mass production, is beginning to be joined by flexible manufacturing. As time goes on, mass production and flexible manufacturing will be joined by agile manufacturing. It is likely all three models will coexist in the global marketplace, perhaps even within the same company. However, companies should recognize each model requires significantly different management approaches. In the future, successful companies will adapt by becoming first flexible, and then agile. Both capabilities will be required.

ACKNOWLEDGMENT

Adapted from Crandall, R. E. (2009). Are flexibility and agility essential to viability? What your business needs to survive and compete. *APICS Magazine*, *19*(6), 23–27. With permission.

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CHAPTER 10B

AGILE MANUFACTURING

NAME AND BRIEF DEFINITION

Agile manufacturing—The ability to respond quickly to unpredictable changes in customer needs by reconfiguring operations (Blackstone, 2013).

Agile or Agility—The ability to successfully manufacture and market a broad range of low-cost, high-quality products and services with short lead times and varying volumes that provide enhanced value to customers through customization. Agility merges the four distinctive competencies of cost, quality, dependability, and flexibility (Blackstone, 2013).

Key elements of agile manufacturing include:

- Customer prosperity–close relationships, customized products, integrated systems,
- People and information–information sharing, knowledge transfer, individual attention,
- Co-operation–trusting relationships, virtual corporations,
- Fitness for change–advanced IT systems, change readiness (Maskell, 2001).

The Agility Forum has defined agility as the ability of an organization to thrive in a continuously changing, unpredictable business environment. Simply put, an agile firm has designed its organization, processes and

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 311–321
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products such that it can respond to changes in a useful time frame" (Prater, Biehl, & Smith, 2001).

Core concepts of agile manufacturing include:

- Core competence management
- Virtual enterprise (enterprise and functional level co-operation)
- Capability for re-configuration
- Knowledge-driven enterprise (Yusuf, Sarhadi, & Gunasekaran, 1999).

Agility is the capability to add or delete products, markets and resources with minimal disruption to the ongoing business. It is the capability to cope with continuous and unanticipated change (Kasardra & Rondinelli, 1998). Agility requires a blending of technology, organization and people (Kidd, 1994).

A key differentiator between flexibility and agility is the level of knowledge about customer demand. Flexibility envisions a high level of knowledge about product mix and demand patterns while agility must accommodate unexpected and undefined demand.

Ketokivi (2006) describes agility as being responsive or reactive to the forces operating in a company's business environment. Prater, Biehl and Smith (2001) list types of exposure for international supply chains as:

- Extent of geographic areas covered by the supply chain
- Political areas and borders crossed
- Number of transportation modes and their speed
- Technical infrastructure and its degree of use
- Random occurrences–earthquakes, floods, avalanches

As exposure increases, agility effectiveness decreases, so trade-offs have to be made between agility, and complexity or uncertainty.

In his book, *Agile Manufacturing, Forging New Frontiers*, Kidd (1994) describes the need for agility in supply chains. "The concept of agile manufacturing is built around the synthesis of a number of enterprises that each have some core skills or competencies brought to a joint venturing operation, based on using each partner's facilities and resources."

While the distinction between flexibility and agility is at times blurred, there is agreement that flexibility is a necessary capability for agility. Agility is the ability to produce and market successfully a broad range of low cost, high quality products with short lead times in varying lot sizes, which provide enhanced value to individual customers through customization (Vokurka & Fliedner, 1998).

Table 10B.1 Comparison of Flexibility and Agility Characteristics

Flexibility	*Agility*
• Predictable variations	• Unexpected changes
• Tactical implications	• Strategic implications
• Production-oriented	• Customer-oriented
• Product variety	• Product customization
• Not necessarily global	• Global perspective
• Technology primarily	• Technology, infrastructure, employees
• Programmable, proactive	• Responsive, reactive
• Incremental change	• Disruptive change
• Controlled demand	• Unpredictable demand
• Established relationships	• Virtual organizations
• Cooperative exchanges	• Collaborative relationships
• Structured decision-making	• Empowered decision-making
• Closed system environment	• Open system environment
• Anticipate what the customer wants	• Make what the customer wants
• Assemble-to-order or make-to-stock	• Make-to-order or engineer-to-order
• Organization centralized, hierarchical, bureaucratic	• Organization decentralized, flexible, organic

Ferdows and DeMeyer (1990) introduced a progressive model for companies to follow. Quality should be established first, then dependability, then flexibility and finally cost benefits will accrue. Later studies extended this model to show a progression from quality to dependability, to flexibility, to agility, to cost efficiency (Vokurka & Fliedner, 1998). Part of their logic confronts this paradox—Cost reduction efforts may not lead to quality improvements; however, quality improvements often lead to cost reductions.

Another study suggests agility is flexibility plus customization. Mass customization focuses on product customization; agility enables a company to respond to other changes, such as government regulation or changes in technology (Krishnamurthy & Yauch, 2007).

"Agility throughout your entire organization is meeting the needs of customers you don't even know you have, for products you don't even know anything about, and being able to support that with systems and communications to suppliers that you don't even know exist—that is what agile is about" (Venables, 2005).

Table 10B.1 contains a list of representative words or phrases collected from the literature to describe flexibility and agility.

Objectives (Reasons for Adopting Program)

Agility has as its primary objective the capability to react to changes in the competitive environment in a positive way. Often, this requires the ability to respond more directly to changing customer requirements.

In his book *The Innovator's Dilemma* Clayton Christensen (2003) describes how many well-managed companies fail to handle disruptive technologies–new technologies that spawn new companies to replace established companies. He claims, "Amid all the uncertainty surrounding disruptive technologies, managers can always count on one anchor: *Expert's forecasts will always be wrong*. It is simply impossible to predict with any useful degree of precision how disruptive products will be used or how large their markets will be. An important corollary is that, because markets for disruptive technologies are unpredictable, companies' initial strategies for entering these markets will generally be wrong." He strongly supports the need for agility as uncertainty and unpredictability increase.

In addition to lean-flexible production concepts, industry leaders have been trying to formulate a new paradigm for successful manufacturing enterprises in the next century. While the vision is still somewhat unclear and some of the underlying support systems do not yet exist, many are labeling this paradigm agile manufacturing. The term "agility" implies breaking out of the mass-production mold and producing much more highly customized products—when and where the customer wants them. It amounts to striving for economies of scope, rather than economies of scale—ideally serving ever-smaller niche markets without the high cost traditionally associated with customization (Sheridan, 1993).

The concept of agile manufacturing is an attempt to respond to the perceived threats posed by economic competitors such as Japanese-based manufacturers. Agile manufacturing has been cited as a new paradigm that will supplant the prevailing mass production, or industrial, paradigm. Business process redesign and business network redesign are the main transformational mechanisms enabling the transition to the new paradigm. Currently, dominant approaches to change generation and management, such as continuous improvement or total quality management, are described as inadequate to foster the desired radical transformation (Burgess, 1994).

Lean manufacturing is a popular initiative for many companies. There is agreement that lean is different. Johnson (2009) explains, "Lean or world class manufacturing is being very good at doing the things you can control. Agile manufacturing deals with the things you can NOT control. Agility is the ability to thrive and prosper in an environment of constant and unpredictable change." Most of the research indicates that while lean manufacturing does not directly improve flexibility and agility, it may fit in a carefully designed supply chain. The term "leagile" reflects this combination. A leagile supply chain contains lean supplier upstream and agile finishers downstream with a decoupling point separating them (Krishnamurthy & Yauch, 2007).

History (Time Line, Reasons Originated, Principal Developers)

As shown in Figure 10B.1, articles about agile manufacturing began appearing in the early 1990s. Early on, Weimer (1992) reports on one study that emphasizes the need for new information and process technologies to achieve agile manufacturing. If U.S. firms have access to the required technologies, the study says, their synthesis into an agile manufacturing system will be dependent on: (1) managing an organization whose dynamic ability depends on spontaneous initiative at all levels of management; (2) developing a culture of continuous creativity and initiative at operational levels of the workplace; and (3) routinely forming multi-enterprise ventures, enabled by the removal of social and legal obstacles to cooperation. If American business and the American people do not respond to the foreign challenge in manufacturing in some very creative ways, the country will continue to decline in terms of wealth and power.

Another early writer also echoed the need for U.S. companies to adapt. In industrial management, the 1980s marked the end of an era dominated by U.S. manufacturers, the alleged masters of mass production. This sys-

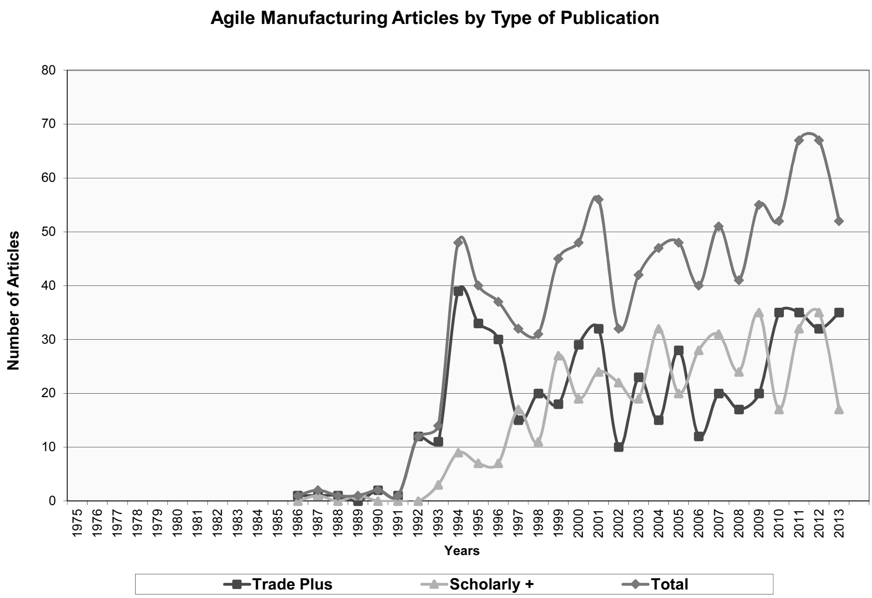

Figure 10B.1. Number of Manufacturing Agility articles.

tem has now been outstripped in several dynamic sectors by flexible/agile production. Increases in the pace of technological progress, training and aspirations have enabled firms to harness the creativity and initiative of a good part of their workforce, thereby providing a competitive advantage. In sectors undergoing relatively broad and rapid change, twenty-first century firms must adopt a more flexible and innovative type of organization to achieve manufacturing excellence (Duguay, Landry, & Pasin, 1997).

The adoption of technological innovations and organizational innovations on the competitiveness of manufacturing enterprises are seen not as objective processes, but as part of managerial decision-making based on management's value systems and agendas. The next stage in the development of manufacturing industry is the emergence of the highly-responsive and "agile" manufacturing enterprise, sometimes taking the form of "virtual companies" to exploit transient or niche markets as they emerge. The key to this agility in a manufacturing enterprise is a more flexible approach to inter-firm cooperation, and development of the creative skills of the management and the workforce (Goldman & Nagel, 1993).

Real agile manufacturing (RAM) is viewed as a strategic process; it is about surviving and prospering in the competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets. RAM is evolutionary, in that it is developed from existing systems of management and technologies. However, it is also revolutionary because the full application of RAM involves a departure from existing systems. RAM is shown to be based upon four fundamentals. First, each partner must benefit; thus multiple winners (manufacturers, suppliers, customers) is the objective. Second, integration (recourses, methods, technologies, departments or organizations) is the means of achieving RAM. Third, IT is an essential condition. Finally, core competence is the key (Jin-Hai, Anderson, & Harrison, 2003).

Figure 10B.1 shows the number of articles about agile manufacturing has slowly increased over the past decade. As common for many management programs, trade journal articles dominated early while scholarly journal articles have increased during recent years.

Expected Benefits (Tangible and Intangible)

Some benefits of agility include:

- Increasing revenues by making what the customer wants
- Increasing prices through customizing products
- Avoiding product obsolescence

- Achieving an agile supply chain
- Competing with low-price, standard products from abroad (Gerwin, 1993).

The underlying motivation for businesses is to have products their customers want; otherwise, no level of cost efficiency will be good enough.

Companies in either manufacturing or servicing have to be restructured or re-organized in order to overcome challenges of the twenty-first century in which customers are not only satisfied but also delighted. Organizations should use a flexible, adaptive and responsive approach: agile manufacturing (AM). An AM system is able to develop a variety of products at low cost and in a short time period. For this, it has some useful enabling technologies and physical tools. Among these, concurrent engineering (CE) is a systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. It is a way to reduce the development time and manufacturing cost, while simultaneously improving the quality of a product in order to better respond to the customer expectations (BuyuKozkan, Derell, & Baykasoglu, 2004).

The competitive advantage in manufacturing has shifted from the mass production paradigm to the one based on fast-responsiveness and flexibility. With the rapid advances in Internet technology, the emerging factory-on-demand mode of electronic production will create a greater opportunity for both producers and customers in the co-creation of products and markets. Such a change will have far-reaching implications in production practice beyond that of mass customization (Lee, 1999).

Agile methods and product line engineering (PLE) have both proven successful in increasing customer satisfaction and decreasing time to market under certain conditions. Key characteristics of agile methods are lean and highly iterative development with a strong emphasis on stakeholder involvement (Noor, Rabiser, & Grunbacher, 2008).

Barriers to Acceptance

As with most major changes, becoming agile is not easy. Major obstacles include:

- Existing resources have limited flexibility
- Resources with increased flexibility cost more
- Agility requires adding resources not presently available

- Agility requires more than manufacturing; it includes market analysis, customer profiling, administrative processes, infrastructure and logistics (Kasardra & Rondinelli, 1998).

Trying to make the process overly agile may increase process costs unnecessarily.
It is difficult to establish performance measures for flexibility and agility. How do you measure agility? Businesses have established measures for cost, quality and response times; however, they are still trying to develop meaningful measures for flexibility and agility.
Extending agility along the supply chain requires a level of collaboration and trust that is not yet evident in most supply chains.

Agile manufacturing, with limited need for prototyping, is the goal in today's fast-moving marketplace. Reaching this goal will require the ability to perform larger, faster, and more complex simulations (Camp et al., 1994).

Implementation Approach

How do companies achieve flexibility and beyond to agility? There are no neat six-step formulas to success. Most of the recommendations of how to proceed are in the form of general guidelines. The Iacocca Institute report coined the term "agile manufacturing" and states agility is required to respond to the new competitive environment that is emerging. Acquiring that agility requires the integration of flexible technologies with a highly skilled, knowledgeable, motivated and empowered workforce, within organizational and management structures that stimulate cooperation both within and between firms (Iacocca Institute, 1991).

Paul Kidd echoes the Iacocca report in his book. "Agile manufacturing can be considered as a structure within which every company can develop its own business strategies and products. The structure is supported by three primary resources: innovative management structures and organization, a skill base of knowledgeable and empowered people and flexible and intelligent technologies. Agility is achieved through the integration of these three resources into a coordinated, interdependent system" (Kidd, 1994).

In essence, there is a need to acquire agility to do things without knowing what will be required; consequently, information, and knowledge management will become increasingly important. Technology is essential but it must be supported with a flexible infrastructure and a willing group of knowledgeable and motivated employees.

Flexibility of supply and demand is essential for successful implementation of a mass customization strategy that delivers sustained competitive advantage. Supply flexibility (i.e., a choice of alternative products designed to perform the same basic function) is made possible by the range of capabilities available in flexible and *agile* manufacturing systems and in supply chains. Demand flexibility is derived from the degree to which a customer is willing to compromise on product features or performance levels in order to meet budgetary (reflected in price) or schedule (reflected in delivery) constraints. Flexibility of both supply and demand can have significant strategic and financial value when properly aligned. Recent advances in information technology make it possible to co-design a product that involves both the customer and the manufacturer. This creates an opportunity where both parties settle for a product that is beneficial to both through a negotiated settlement (Chen & Tseng, 2007).

Future

Focused, or mass production, is beginning to be displaced by flexible manufacturing. As time goes on, mass production and flexible manufacturing will be joined by agile manufacturing. It is likely all three models will co-exist in the global marketplace, perhaps even within the same company. However, companies should recognize each model requires significantly different management approaches. In the future, successful companies will adapt by becoming first flexible, and then agile. Both capabilities will be required.

ACKNOWLEDGMENT

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CHAPTER 10C

MASS CUSTOMIZATION

NAME AND BRIEF DEFINITION

Mass Customization—The creation of a high-volume product with large variety so that a customer may specify his or her exact model out of a large volume of possible end items while manufacturing cost is low because of the large volume. An example is a personal computer order in which the customer may specify processor speed, memory size, hard disk size and speed, removable storage device characteristics, and many other options when PCs are assembled on one line and at low cost (Blackstone, 2013).

Pine wrote the first definitive book on mass customization and explains mass customization as "the new frontier in business competition for both manufacturing and service industries. At its core is a tremendous increase in variety and customization without a corresponding increase in costs. At its limit, it is the mass production of individually customized goods and services. At its best, it provides strategic advantage and economic value" (Pine, 1993).

Hart (1995) also considers defining mass customization as a challenge. He suggests two definitions:

- Ideal—"Mass customization is a business strategy for profitably providing customers with anything they want, anytime, anywhere, in any way."
- Realistic—"Mass customization is the use of flexible processes and organizational structures to produce varied and often individually

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 323–331
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> customized products and services at the price of standardized, mass-produced, alternatives."

Mass customization does not always provide the customer with exactly what they want; however, it does provide the customer an opportunity to choose among a wide array of alternatives.

Objectives (Reasons for Adopting Program)

How do the customer and the supplier assess the value of mass customization? Is customization always attractive to a customer? Is there ever a point where increased variety or customization becomes a negative in the minds of the consumer? Customized jeans to provide a better fit may be highly desirable; however, having 36 varieties of canned tomatoes may be frustrating and even introduce stress into the everyday lives of consumers (Schwartz, 2005; Nelson, 2001). Table 10C.1 lists some of the factors that affect customer desire for mass customization.

Companies have to determine whether their customers care about more customization. They should evaluate both customer needs and the willingness of customers to sacrifice, or put up with the "hassles, inconveniences, discomfort, long waits, product or service deficiencies, high cost, difficulty of ordering, lack of fulfillment options, and much more" (Hart, 1995).

A study of automobile manufacturing found that customers cite only body style, engine, exterior color and type of radio as critical to the purchase decision. Yet companies are spending a fortune to enable variation in options customers may not care about. The authors caution, "Whatever managers decide to spend, they shouldn't proceed with a BTO transition

Table 10C.1. Levels of Desire to Customize

Factors	*Low Desire to Customize*	*High Desire to Customize*
Price	Low (note paper)	High (diamond ring)
Useful life	Short (can of peas)	Long (portrait painting)
Complexity of product	Low (screwdriver)	High (automobile)
Fit	Not visible (underwear)	Visible (jeans)
Comfort	Not critical (sweatshirt)	Critical (shoes)
Style	Not important (automobile tires)	Important (hair style)
Customizing by consumer	Easy (mixing cereals)	Difficult (mixing concrete)

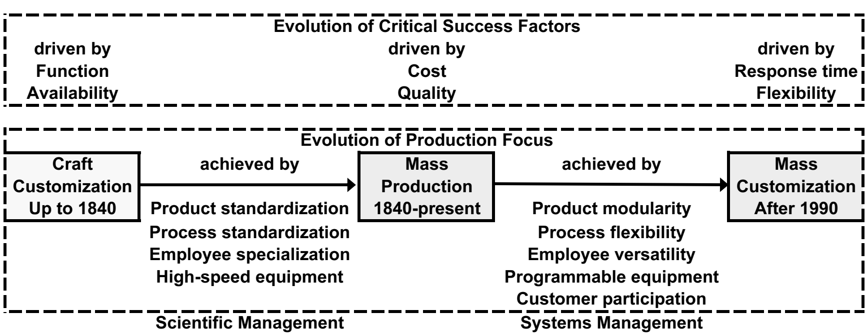
without thoroughly understanding the key aspects of customer demand. It's important to ask what variety the customer really wants, as opposed to what the marketing department wants" (Holweg & Pil, 2001).

Everyone agrees that the transition to mass customization is a big change for the customizers. It will also be a major transition for the customer who must learn a new way to buy.

History (Time Line, Reasons Originated, Principal Developers)

Figure 10C.1 shows the evolution of manufacturing from the craft age to mass production to mass customization. The dates are approximate and should convey that while mass customization has started, mass production is still the dominant way of operating.

The top portion of the diagram illustrates how critical success factors have changed through the different stages—from function and availability during the craft age, to cost and quality in mass production, to response time and flexibility in mass customization. The bottom portion of the diagram shows that mass production was achieved through product and process standardization, employee specialization, and high-speed equipment. It was driven by the scientific management movement spearheaded by Frederick Taylor. The move to mass customization will be achieved through product modularity, process flexibility, employee versatility, programmable equipment and, most important of all, customer participation. Scientific management will give way to systems management. However, the transition from mass production to mass customization is in



Source: Adapted from Crandall (2007).

Figure 10C.1. The evolution of product and service delivery methods.

the early stages. While mass customization is becoming more popular, it is a long way from replacing mass production.

Most manufacturers use one of the following strategies—make to stock (MTS), assemble to order (ATO), make to order (MTO) or engineer to order (ETO). See Blackstone (2013) for fuller definitions.

In theory, it is impossible to move from a MTS environment to a mass customization environment because mass customization requires that the customer define the product; however, in MTS, the product is made before there is a customer. In practice, MTS manufacturers try to satisfy the mass customization requirements by anticipating (forecasting) what the customer will want and producing that product so that the customer will find a "near fit" with what they would like to have. Forecasting is difficult for standard products; it is nearly impossible for specialized products. This means that the manufacturer must produce a wide variety of products for specific market niches. They believe that if they provide enough variety, the customer will be satisfied in a setting that approaches mass customization.

The last three strategies—ATO, MTO and ETO—all have some capability to respond to the customer. The problem is that the more customizing the supplier does, the longer it takes. Therefore, the ideal situation would be to retain the customizing capability while reducing the response time to the customer.

Figure 10C.2 shows the total number of articles written about mass customization, divided into those from trade magazines and those from scholarly journals. The articles began appearing in the late 1980s and grew rapidly until the mid-1990s. They declined through 2003 when they increased again through 2007 as a result of a greater number of scholarly articles. The early articles were dominated by trade publications while recent articles are primarily from scholarly journals.

Expected Benefits (Tangible and Intangible)

In theory, mass customization provides the customer with exactly what they want at the same price and in the same time as a standard item. In practice, they get what they want (or something very close) at only a slightly higher price and almost as fast. By spending the time to make choices, customers become more knowledgeable buyers and expand their opportunities to find products and services of greater value.

In theory, customizers get additional revenues from the customized goods and services they provide, by either gaining a higher share of the market or selling their products at a higher price. In practice, their gains may be only short-term, especially if their competitors match their cus-

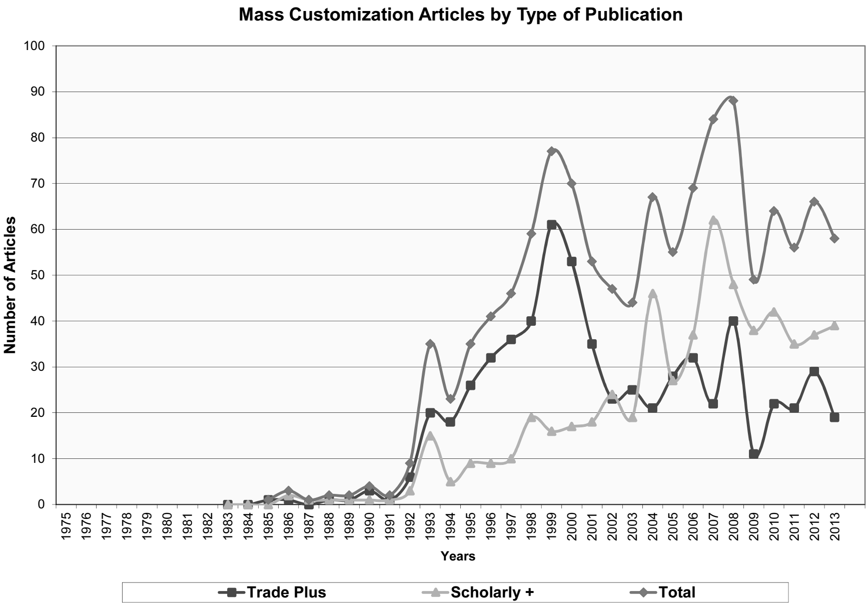


Figure 10C.1. Total number of Mass Customization articles.

tomizing strategies. They should reduce the total cost of their inventories by matching what they stock more closely to what they sell. There may also be some less obvious benefits to the producers. They gain flexibility in making variations of their existing products, a worthwhile skill as they move to newer products in the future.

Barriers to Acceptance

Mass customization is not without its drawbacks. Businesses must build relationships with customers, redesign modular products, revise processes to increase flexibility, and reorient employees from job specialization to job enlargement and empowerment. The potential benefits may not provide an acceptable return on investment (Albright, 2006).

Traditionally, many manufacturers developed processes with heavy emphasis on high-speed and specialized equipment and specialized employees. To change to mass customization will require a new blend of general purpose equipment and more dependence on broader-skill employees. It is not likely that the correct balance can be determined ahead of time; therefore, it will be determined over time in an evolutionary manner.

Perhaps not all of the production capacity will be transformed; consequently, there will be a mix of different manufacturing methods to handle both the continuing mass production along with the new mass customization. This increased complexity may make mass customization an unattractive intrusion to the production organization.

Another complication is the trend toward offshore outsourcing. While there are opportunities to add suppliers that provide customizing capabilities not available internally, outsourcing adds complexity to the flow of goods and services, and increases response times, an undesirable factor in mass customization.

Some of the factors that may discourage the consumer from choosing mass customization include a longer response time to get the product or service, a possible decreased resale value of the product and the need to make multiple decisions in order to specify their choices.

Implementation Approach

The components of a mass customization strategy include a learning relationship between customer and supplier to identify the customer's needs, a collaborative product design, and a flexible production process to convert the design to a product or service (Hart, 1995).

In speaking of the successful (and profitable) implementation of flexible, responsive production for custom products, Goldhar and Lei (1995) indicate, "For the most part, these changes are likely to require much tighter integration of strategy and structure; of knowledge work with physical work; of technology, marketing and production; and of people with technology."

Gilmore and Pine (1997) describe four approaches to mass customization. **Collaborative customizers** conduct a dialogue with individual customers to help them articulate their needs, to identify the precise offering that fulfills those needs, and to make customized products for them (eyewear). **Adaptive customizers** offer one standard, but customizable, product that is designed so that users can alter it themselves (programmable lighting systems). **Cosmetic customizers** present a standard product differently to different customers (monogrammed T-shirts). **Transparent customizers** provide individual customers with unique goods or services without letting them know explicitly that those products and services have been customized for them (industrial soap mixtures). They warn that successful companies should customize their goods and services only where it counts.

The move to mass customization is a major strategic consideration for companies; the attractiveness of the change varies among industries. Pine (1993) uses "market turbulence" (an indicator of change) to guide companies when they consider the switch from mass production to mass customization. When the market turbulence is low (measured on a number of factors, such as length of product life cycles, rate of technology change, and the like), he believes mass production is still adequate. As market turbulence increases, the prospects for mass customization increase. Electronics is an industry with high turbulence and in need of mass customization. On the other hand, wood products, such as plywood and 2" x 4" lumber, can still be adequately served by mass production.

The switch to mass customization is a radical change. It involves a systems approach and requires changes in technology, company structure and even the culture of the company. First, top management must decide to move to mass customization. It requires an implementation plan and an organization structure to facilitate the change. It requires developing relationships with customers to find out what they really need, not just want. It requires internal changes to develop modular products and flexible processes to make and distribute the products and services. It requires new technology such as interorganizational systems to communicate with customers and suppliers. It requires a change in employee orientation, from job specialization to job enlargement and empowerment. Finally, it requires a learning environment to keep pace with the changing marketplace.

Grenci and Watts (2007) raise the issue of electronic mass customization. They point out that traditional mass customization deals primarily with the production of goods and involve computerization, modularization and interconnectivity. Moving to electronic mass customization requires a customer service orientation involving decision support to help customers make decisions, bundling products and services, and cross e-tailing (e-tailers selling for one another).

One question that manufacturers and service providers face is: How much of our business do we shift from mass production to mass customization? All of it? Or only part of it? Should we have a blend of the two? One suggestion is that companies blend mass customization with offshore outsourcing by having an offshore supply for low-cost standard products or components, and a domestic facility to customize products for customers (Cattani, Dahan, & Schmidt, 2005).

Future

While there are a number of examples of successes, there is little evidence that it is a "hot button" for the business community. Even Dell, who has been the shining example of mass customization, has seemingly rejoined the mass production ranks by announcing that they will sell some of their PC models through Wal-Mart. Most of the current emphasis among businesses seems to be on building integrated supply chains or solving the need to link computer networks into interorganizational systems (IOS). Both integrated supply chains and IOS are needed for mass customization; however, the present emphasis is on standard products, not customized products. Most businesses are still feeling their way along the transition path from mass production to mass customization. Consequently, mass customization is more than a fad but is not yet a fashion in the management program literature.

Mass customization is not a bad idea but an idea that must be selectively applied. Businesses will become better at deciding how to blend mass customization with mass production and all of the variations in between such as lean and agile production. Success will probably depend more on the pull of the customer for more customization than the capability of the customizer. It is more likely to evolve in services with higher labor content because it is easier to use human beings to perform the customizing function than to redesign products and processes.

However, don't expect a reversal in the trend toward mass customization. It may only be mini customization now but the days of binary buying decisions (buy or don't buy) are steadily being replaced with choosing "brand X organically grown cubed tomatoes with okra packed in distilled water in a #10 recyclable can with an easy open top" from the 36 choices available.

ACKNOWLEDGMENT

This chapter is adapted from Crandall, R. E. (2007). Mass customization's many faces. *APICS Magazine, 17*(7), 24–27. Permission requested.

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CHAPTER 11A

INTERNET EDI (I-EDI)

NAME AND BRIEF DEFINITION

Electronic Data Interchange (EDI)—The paperless (electronic) exchange of trading documents, such as purchase orders, shipment authorizations, advanced shipment notices, and invoices, using standardized document formats (Blackstone, 2013).

Internet-based e-commerce evokes the perspective of cost reductions, faster transaction processing, and global markets. Until recently, e-commerce was generally confined to business-to-business transactions within strictly closed EDI communities with highly integrated trading systems. Many observers think the advent of the internet can reenergize traditional EDI, with new Internet-EDI applications could allow the transition from closed to open networks and extend the application of e-commerce to broader business communities (Gottardi, 2004).

Objectives (Reasons for Adopting Program)

As Internet security encryption and virtual private networks (VPNs) get better, manufacturers are adopting Internet-based methods to transfer transactional data, and in some cases, turning away from the service providers that have been supporting the electronic exchange of transactional data. However, that doesn't mean the providers that carved out a lucrative niche in making EDI work are threatened with immediate extinction. Deciding whether to use service providers for traditional EDI or switch to

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 333–340
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Internet EDI can be a complex decision, especially if legacy EDI is in place (Bury, 2005).

History (Time Line, Reasons Originated, Principal Developers)

Traditional Electronic data interchange (EDI) became available to companies in the early 1970s as a means of transferring information electronically from one business to another. One of the more popular applications was in order processing. A business could place an order with a supplier, who would acknowledge the order, and ship the order with an invoice. The receiving business could prepare a receiving report, match it with their purchase order and the invoice, and authorize payment through their bank, which would send the payment to the supplier's bank. This process eliminated paperwork because all of the transactions, and accompanying documents, described above were electronic. EDI reduced costs of order processing by as much as 90%, reduced errors, speeded up deliveries, and reduced the time required of employees to identify errors or track orders. The biggest problem was that it was expensive to implement and operate. As a result, only a small fraction (less than 5% in 1995) of the businesses adopted EDI (Lankford & Johnson, 2000). Many of those that used EDI did so reluctantly because their major customers demanded it. Because it was a one-to-one kind of communication, it was secure. However, it required that each customer-supplier relationship be set up individually.

Large companies implemented EDI and found it worth the investment. Some of the major applications included global communications, financial funds transfers, health care claims processing, and manufacturing and retailing (Kalakota, 1996). Small companies could not achieve the volume necessary to make it a worthwhile investment. If they had to use EDI to do business, they usually did it through value-added networks (VANs), entities that facilitated the transfer of information between customer and supplier. Using a VAN eliminated a portion of the initial investment cost, but did not change the high transaction costs. Sawabini (2001) reported, "Where EDI fails, it is because (1) it is cost prohibitive and too complex for smaller suppliers; and (2) it offers few bottom-line benefits for suppliers."

In the early days, users viewed EDI as an inter-organizational system (IOS). In recent years, as the concept of an IOS has enlarged, writers now view EDI an element of an IOS. At the most extreme, EDI is simply the means of standardizing the data formats used in transferring information (Kalakota, 1996).

Electronic data interchange (EDI) is a special kind of electronic commerce, referring to paperless business-to-business transactions untouched

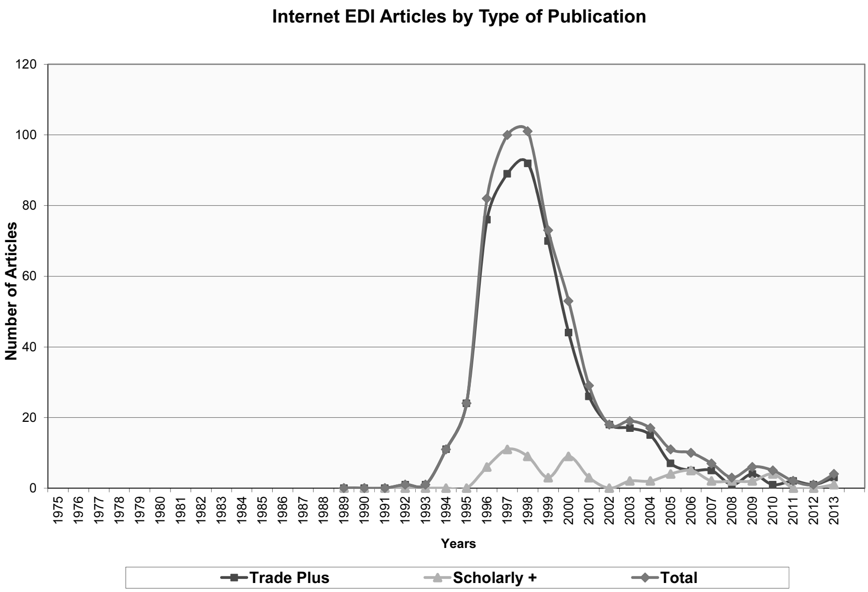

Figure 11A.1. Number of Internet EDI articles.

by human hands. EDI focuses on improving management of the supply chain, with the strategic goal of reducing the number of suppliers. Electronic commerce is a pervasive force that is, in a sense, driving all business and personal financial transactions toward the EDI goal of computer-to-computer communications. The arrival of the internet expanded the possibilities for its use in EDI (Segev, 1997).

Figure 11A.1 shows the number of articles published exclusively for Internet EDI. Articles began appearing in the mid-1990s and grew rapidly until reaching a peak in 1998. It is difficult to separate the articles written about EDI in general and those written specifically about EDI using the Internet. While the number of articles about EDI has declined in recent years, it does not indicate a decrease in interest. It is more likely the result of companies blending their EDI efforts with other programs, such as Interorganizational Systems (IOS).

Expected Benefits (Tangible and Intangible)

The Internet offers a number of compelling advantages over value added network-based EDI. Internet EDI transactions cost from one-half to one-tenth the price of VAN-based transactions, according to some studies. After futile attempts to protect their proprietary turf, traditional EDI and VAN providers decided to jump on the Internet bandwagon. They have rushed to the market with Internet-based EDI products and services priced far more frugally than ever before (Adams, 1997).

Driven by the prospect of saving thousands of dollars a month, more and more trading partners are sending EDI messages over the Internet—the closest thing in networking to a free lunch—rather than over third-party network services, according to vendors and analysts. Although such a move can pay for itself in as little as two months, it requires customers to do some of the work the VAN used to do, such as making sure the proper person is notified if a purchase order or invoice doesn't get through. However, if customers can cost-effectively become their own VANs and choose the right Web EDI tools, the savings can be compelling (Scheier, 2003).

Internet EDI looks attractive because of the lower costs potential. The initial investment is lower and the transactions costs are lower (Angeles 2000). In addition to the lower costs, Senn (1998) suggested the following reasons why the use of the Internet is attractive:

- Publicly accessible network with few geographical constraints
- Offers the potential to reach the widest possible number of trading partners
- Powerful tools facilitating interorganizational systems are becoming available
- Consistent with the growing interest of business in increasing electronic services
- Can complement or replace current EDI strategies
- Leads to an electronic commerce strategy

Internet also offers close to real time transactions because there is no longer the need to go through VANs who use the batch-and-forward method of transmitting information.

One study found that the Internet-based electronic market outperforms the EDI-based channel on two important measures. Order cycle times were significantly lower when using the Internet-based electronic market, whereas the percentage of complete shipments was significantly higher after controlling for product, transaction, seller, and buyer-specific factors. The electronic market even outperforms the EDI channel when buyer and transaction characteristics favor the use of EDI. Because EDI is still prevalent in many industries, these results point to the gains that may be realized by switching to the newer technology (Yao, Dresner, & Palmer, 2009).

By taking advantage of the Internet, a new generation of Interorganizational Information Systems (i.e., Internet electronic data interchange (I-EDI) provides great efficiency for performing business-to-business transactions and is much more affordable than other network alternatives). While some new factors are found to play important roles in IOS adoption, several conventional factors, such as technology compatibility and organization size, are no longer significant in explaining the adoption of I-EDI. Different effects of interorganizational factors such as power, trust, and relationship commitment on I-EDI adoption have been revealed. Implications for researchers and practitioners are provided (Huang, Janz, & Frolick, 2008).

Barriers to Acceptance

One of the most frequently heard objections to the use of the internet for EDI purposes is the potential loss of privacy. Traditional EDI was viewed as very secure while the internet is subject to potential invasion by external parties. One study found this, and other barriers to the adoption of Internet EDI. The Internet Engineering Task Force suggests the following essential measures be taken to defend against security threats when an EDI transmission is sent via the Internet: (1) confidentiality; (2) content integrity; (3) authentication and non-repudiation; (4) signed receipt and non-repudiation; and (5) syntax and protocol for transmitting the cryptographic transaction (Askelson, 1997).

Implementation Approach

Traditional EDI is a proven method of transmitting data between entities. Where there is sufficient volume, it is of significant benefit. Unfortunately, only a limited number of companies have the requisite volume. A promising supplement is Internet EDI, when the level of security can be raised to acceptable levels. Other approaches include the use of portals—access point (or front doors) through which a business partner accesses secured, proprietary information from an organization. These portals may be distribution portals (single supplier, multiple buyers), procurement portals (single customer, multiple suppliers), or trading exchanges (balance between suppliers and buyers) (Jessup & Valacich, 2006). Until some approach dominates, a company may use a hybrid approach, such as to continue to use traditional EDI for the more sensitive data applications and move more deliberately into Internet EDI with less sensitive data, using trading portals where they offer benefits. As with any worthwhile innovation, the widespread diffusion of electronic data exchange will take time and will likely involve changes in direction or emphasis during its life cycle. EDI is actively being deployed in a number of major industries, including automotive, financial services, high tech and retailing (EDI Basics, 2015).

Future

Research suggests that Internet EDI will become more widely used because of its lower costs than traditional EDI. At the same time, traditional EDI will also become more widely used because of its advantage over paper processing. Both forms of electronic data interchange will realize their potential in the development of inter-organizational systems (IOS). With the ever-expanding global business community, it is no longer possible to use hard copy documents in most business transactions. The speed and efficiency of electronic information is compelling businesses to make the transition to paperless systems. While Internet EDI may become the standard at some point in the future, traditional EDI will remain a significant factor for several years because it is a proven method and many companies already have an investment in their present systems.

Like many innovations, the use of the Internet as a replacement for traditional EDI has many supporters, some of whom have a stake in seeing it succeed. Technology opportunities abound. For those that understand the technology, it is like being in a candy store trying to decide which treat to choose. For those that do not understand, it is a jungle with danger lurking behind every acronym. For a more complete description of the technology involved, see Kalakota and Whinston (1996), Jessup and Valacich (2006), and the EDI Institute at www.ediuniversity.com. An article by Jackson and Sloane (2003) traces the history of EDI and provides a comparison of various models and frameworks used to describe the role of EDI in the development of IOS. While the future looks promising, Internet EDI is not without some hurdles.

Any IOS is more than technology. It also includes organization and people. Trust between participants is necessary if the relationship is to be an effective one, supporting collaboration among entities. Even if the cost and security issues can be resolved, the trust issue may remain. Ruppel (2004) found that company culture and trust were significant issues when it came to the use of EDI in either the traditional or Internet format. In order to move from coordination to collaboration, trust is required.

EDI, either traditional or Internet, cannot stand alone. To be completely effective, a company should integrate it with its mainstream information systems (Sawabini, 2001). This requires the capability to interface two disparate systems or to modify the EDI system to allow integration of the data into the main systems, such as Enterprise Resource Planning (ERP), Supplier Relationship Management (SRM), or Customer Relationship Management (CRM).

ACKNOWLEDGMENT

A portion of the description of this program has been abstracted from Crandall, R. E. (2005). Exploring Internet EDI. *APICS Magazine, 15*(8), 18–20.

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CHAPTER 11B

BUSINESS TO BUSINESS (B2B)

NAME AND BRIEF DEFINITION

Business-to-Business Commerce (B2B)—Business being conducted over the Internet between businesses. The implication is that this connectivity will cause businesses to transform themselves via supply chain management to become virtual organizations, reducing costs, improving quality, reducing delivery lead time, and improving due-date performance (Blackstone, 2013).

B2B involves establishing a system, a network, to do business. (Hollyoake, 2009). B2B is an extension of electronic communication between organizations; it is a more formal way of doing business. In the 1970s, companies began developing Interorganizational Systems (IOS) as a means of reducing transaction costs and obtaining faster and more accurate information flow with their primary suppliers, largely through direct electronic data interchange (EDI) connections.

Objectives (Reasons for Adopting Program)

The primary objective is to establish communication links (connectivity) between companies to enable them to do business in a more consistent way. In manual transactions, there is great latitude in how transactions are handled because of differences among companies. Employees interpret variations among organizations and compensate for these differences to complete the transactions.

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 341–350
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In establishing communication links, it is appropriate to decide whether their objective is for short-term transactions that are focused primarily on transaction costs without the requirement for continuing relationships. If the objective is to establish long-term, continuing relationships, there will be a requirement to consider more than transaction costs, such as trust and dependency (Bunduchi, 2008).

From a broader perspective, an IOS enables a company to concentrate on its core competencies while relying on their partners for support activities (Asher, 2007). Among the more tangible benefits from IOS, and its partner, B2B, are cost reduction, cycle time reduction, elimination or reduction of paper, and reduction of errors in the manual process (Asher, 2007).

In electronic communications systems, it is necessary to embed a level of standardization, or consistency, among participants. Computers, instead of humans, are required to complete transactions; they can't do that if there are variations from prescribed procedures. In order to achieve an acceptable level of standardization, organizations have to work together and agree on the standards to be used.

Another objective for a B2B system is to use it as a means of doing more business with the connected organizations. It becomes more than a technology-based network; it is a marketing strategy that can be beneficial to the connected entities. Mangers seek to develop new solutions to the age-old challenges of improving customer responsiveness, shortening product development cycles, and accelerating time to market (Brewton, 2001).

History (Time Line, Reasons Originated, Principal Developers)

The roots of B2B are in interorganizational systems (IOS), one of the first major efforts to establish rapid and accurate flow of information between companies. One of the key technologies to facilitate IOS was electronic data interchange (EDI). See the description of EDI in another section of this book. However, EDI was costly to implement and was used primarily by larger companies. With the development of the Internet, traditional EDI has morphed into Internet EDI; consequently, the use of electronic communication systems has grown, so that even small companies can participate. The Internet has also given rise to electronic intermediaries. Traditional EDI was based on a "hub and spoke" concept, where the principal customer had direct access to a selected array of suppliers, electronic intermediaries could offer a gateway between a number of suppliers with a number of customers (Humphreys, McIvor, & Cadden,

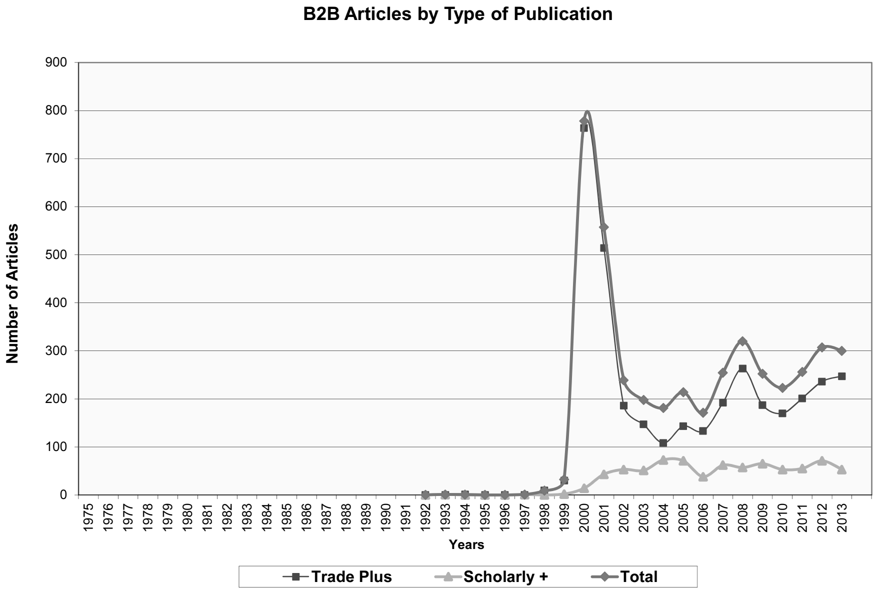

Figure 11B.1. Total number of B2B articles.

2006). Even with the advent of newer technologies, EDI remains the backbone of many B2B systems (Asher, 2007).

Figure 11B.1 shows publications about B2B started about 1998 and exploded in 2000, probably as a result of the Y2K concerns. Although the rate has diminished, there are still a high number of articles, primarily in trade journals. Publications in scholarly journals have been steady, but at a lower rate.

During the early stages of E-Business development, much of the attention in the media surrounded business-to-consumer (B2C) possibilities. While B2C still captures much attention, through such successes as Amazon and eBay, most of the transaction volume is in B2B. Some of the reasons for the greater success of B2B are:

- Large companies are better prepared to communicate electronically, from both technical and financial perspectives. They already understand and have in place much of what is needed to launch a B2B program.
- Companies are more cost-conscious and are constantly looking for ways to reduce costs, especially those that do not add value to their product and service offerings.

- As companies find value in IT, they anticipate more savings and revenue benefits by encouraging other partners in their supply chains to do the same. Success breeds success.
- Companies are more likely to recover from the rash of e-business failures during the early stages of their development and move on to realizing the benefits of the new technologies (Coltman, Devinney, Latukefu, & Midgley, 2002).

Expected Benefits (Tangible and Intangible)

Early movers in B2B may have been interested in reduced communication costs; however, they soon recognized the opportunity for increased revenue. Expected reduction in administrative costs yielded in importance to the expectation that improved relationships with customers could lead to increased sales.

Improved communications could lead to improved and more durable relationships. Customer retention became an objective and led to additional programs such as Customer Relationship Management (CRM). This led further to improved information exchanges to help in forecasting demand, not only in quantity and timing of existing products but also in identifying new product development needs and opportunities.

Less tangible, but probably equally important, is that companies participating in B2B networks acquired skills in using new technologies that could move them into a more attractive role as supplier or customer. A failure to keep pace with emerging technology could send a negative signal to both customers and suppliers.

Barriers to Acceptance

As with any new technology, especially in the rapidly changing world of the Internet, computers, supply chain relationships and market globalization, there are barriers to its adoption and successful implementation.

Reluctance to Change

Some managers show a reluctance to adopt new technologies, whether because of their own inclinations or because of the culture within the organization. This is often true of very successful companies, where there is a belief that they should continue what has made them successful.

Failure to Acquire Adequate Knowledge About the Technology

A superficial knowledge about B2B programs may limit an organization's ability to evaluate or implement it successfully, either because they have expected too much or done too little. Brewton and Kingseed (2001,

p. 30) found the following reasons for dissatisfaction in B2B implementations:

- Companies fail to appreciate all the ways that B2B transactions affect multiple elements of complex supply chains
- Companies take a myopic view of the Web as a transaction engine, versus a suite of tools for managing customer interaction
- Companies implement B2B approaches and tools without clear understanding of their strategic ramifications.

Failure to Obtain Internal Acceptance

While B2B is dependent on technology as a driver, it is also necessary to gain acceptance among key employees and be prepared to change policies and infrastructure to accommodate the new program.

Failure to Obtain External Acceptance

Just as it is essential to change within an organization, it is necessary to select and establish working relationships with other participants. In addition to acceptance from external participants, there is the very large task of blending information systems—hardware, software, procedures and common interests.

High Design and Implementation Costs

There are significant costs involved in implementing a B2B program. There are initial investment costs in technology, education and facilities. In addition, there are ongoing costs in information collection and maintenance, modifications to the system, and continuing education and relationship building (Asher, 2007).

Technology Incompatibility

No matter how cooperative interested parties may be, there is likely to be system capability problems. In some cases, they require only minor adjustments. However, the gap between the two may be so large that the finished implementation is less that completely satisfactory. One study found the following implementation problems:

- Different standards used by different customers
- Numerous systems used by different customers
- High initial costs associated with building the infrastructure and acquiring the necessary technological skills (Asher, 2007).

In some cases, the communication is not directly between customer and supplier, but through a third party, or intermediary, which further complicates the compatibility issues.

Complexity of Relationships

B2B relationships are complex. In addition to the technology compatibility problems, organization structures, policies, strategies, locations, employee education, and cultures are all different. In a *B2B* model, it is not uncommon to market to one individual in the organization and have the actual order placed by a subordinate, administration or colleague. Attributing responses to marketing stimuli becomes incredibly difficult in the B2B world (Goldman, 2008).

Implementation Approach

While implementation of a B2B program has some unique requirements, it also has many of the same elements as the implementation of any new technology. Insofar as B2B is concerned, Brewton and Kingseed (2001) offer these keys to unlocking the potential of a B2B program:

- **Look carefully before leaping**. Ask questions about the readiness of the technology to perform as expected. Many problems can be prevented by systematically examining all of the steps necessary to implement a B2B program. It is less costly to prevent a problem than to solve it after the program is up and running. This is applicable not only to the internal transactions to be performed but also to the transactions between partners.
- **Look beyond B2B to leverage the Web investment.** While B2B may be the primary attraction, there are other applications that merit attention, such as work flow tracking, net meetings, program management, hosted applications, and knowledge management. Careful questioning of potential problems or lapses in the system can make for a smoother implementation.
- **Make sure B2B efforts are aligned with the company's total business strategy.** Obviously, the B2B programs should fit within the framework of the corporate strategies and be a major contributor to them. In addition, the B2B program must recognize the tasks required to bring customers on board with the program, including education, technology adaptation and acceptability of the B2B program.

Hollyoake (2009) presents a long-term perspective on building a B2B program. He uses the four pillars of communication, integrity, trust and interdependence as the ultimate objective in developing an effective and lasting relationship.

Another way of looking at an implementation approach is to consider four models of the relationship that can be established within the B2B framework. They are:

- **Established buyer-supplier relationship**—a pre-determined one-to-one relationship between a buyer and supplier supported by electronic commerce technologies and typically used in procurement of strategic items.
- **Supplier-oriented marketplace**—a supplier-provided marketplace that can be used by both organizations and individual consumers. This is sometimes presented as an auction of goods.
- **Buyer-oriented marketplace**—a buyer opens an electronic market on its own server and invites potential suppliers to bid on the announced requests for quotation. This is the opposite of the supplier-oriented marketplace and is known as a reverse auction.
- **Business-to-business intermediary**—sometimes referred to as a hub or exchange. It is established by a third party that provides a marketplace where both buyers and suppliers participate. Often, they focus on no-core items and may be organized as either vertical (industry oriented) or horizontal (across industries). These exchanges can be closed (only to members) or open (to all) (Humphreys, McIvor, & Cadden, 2006).

Although these arrangements exist, only the first has a long-enough history to be considered an established process. The last three are still in the developmental stage and, while each has a definite role, their final form is still taking shape.

Future

It appears that B2B is a program still in its early stages of growth. Although the transition may take years, or even decades, it is intuitively attractive to expect that electronic information communications between companies and nonprofit organizations will increase. Some of the specific expectations will include:

- The underlying infrastructure will have to improve before there is full development of all forms of electronic communication, including B2B.
- Internet search tools will become more sophisticated and advances in XML will make it possible to identify products, features, and prices with far greater precision.

- Buyers will be able to set much more detailed search criteria, giving them access to even richer sources of information.
- Innovations in technology will dictate the pace at which intermediaries will evolve to add value and encapsulate items of greater complexity. Intermediaries will have to develop added skills and services to become a major factor (Humphreys, McIvor, & Cadden, 2006).

While B2B, among other E-Business programs, will grow, there are some significant hurdles for businesses to overcome. They include:

- Greater transparency of an organization on the Internet will lead to a greater reluctance to pay full prices and put greater pressure on cost reduction. This may cause some to view the Internet not as an opportunity, but as a threat.
- A culture change will be required to enable customers and suppliers to engage in open exchanges of information. This will require a level of trust not present today in most business relationships.
- There must be a higher level of interorganizational systems compatibility. Even if the participants are willing, they must have the technology to create effective interfaces.
- Understanding and implementing change management initiatives will be required if companies are to be able to establish long-term, productive relationships. This will involve changes in technology, infrastructure, and cultures (Humphreys, McIvor, & Cadden, 2006).

Electronic commerce is more than technology and requires the participation and endorsement of top management in formulating strategies that will benefit not only individual companies but also the entire supply chain.

As companies move toward greater use of E-commerce and beyond their treatment of it as a technology, it will be necessary to involve all functions in an organization with their counterparts in adjoining organizations.

While individual consumers are getting the majority of the attention, business customers have become just as demanding of the companies they deal with, and that will drive major changes in corporate selling and service over the next 2 years, according to a new survey of business-to-business executives by Accenture. The survey indicates that business customers have higher expectations, want more customized solutions, are more price-sensitive, and have greater knowledge of the product than ever before, which demands that B2B companies sharpen their focus on improving the customer experience.

Some ways B2B companies can improve their offerings include:

- Assign a leader close to the P&L, to make sure that investments in customer experience are strategic and will be prioritized on their merit and results, not just improvements around the edges of the business.
- Build on a strong foundation. With the increase of digital technologies such as mobile, analytics, and cloud, companies need to adapt to a sales and service model for the nonstop customer, in which the journey toward purchasing a product is much more fluid and continuous.
- Be digital, but do not ignore traditional (analog) interactions, which include things like seamless integration across call centers or field sales; they remain important parts of the mix, and a complement to digital capabilities.
- Update how to choose investments. Successful companies align their customer experience efforts and metrics with those areas that matter most to their customers, instead of making improvements that may seem important, but do not clarify how much customers value them.
- Strengthen the experience. Customer experience operations should be constantly measured and evaluated and the results shared across the organization to encourage improvement, based on performance and feedback from customers.

Accenture's research found that the companies successfully implementing the above best practices yield, on average, up to twice the return on their customer experience investments (Wollan, 2014).

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CHAPTER 11C

BUSINESS TO CONSUMER (B2C)

NAME AND BRIEF DEFINITION

Business-to-Consumer Sales (B2C)—Business being conducted between businesses and final consumers largely over the Internet. It includes traditional brick and mortar businesses that also offer products online and businesses that trade exclusively electronically (Blackstone, 2013).

Objectives (Reasons for Adopting Program)

The primary objective of a B2C program is to enable a business to sell products and services to individuals, instead of other businesses. At this time, it is competing with the traditional "bricks and mortar" retail stores, to which consumers have become accustomed.

The Internet changes the way that business is done in several ways. Electronic commerce can change the inter-organizational processes involving buyer-supplier relationships, reshape buyer-supplier relationships, improve a business's core processes, and help a business reach new markets or segments through the electronic medium (Murtaza, Gupta, & Carroll, 2004).

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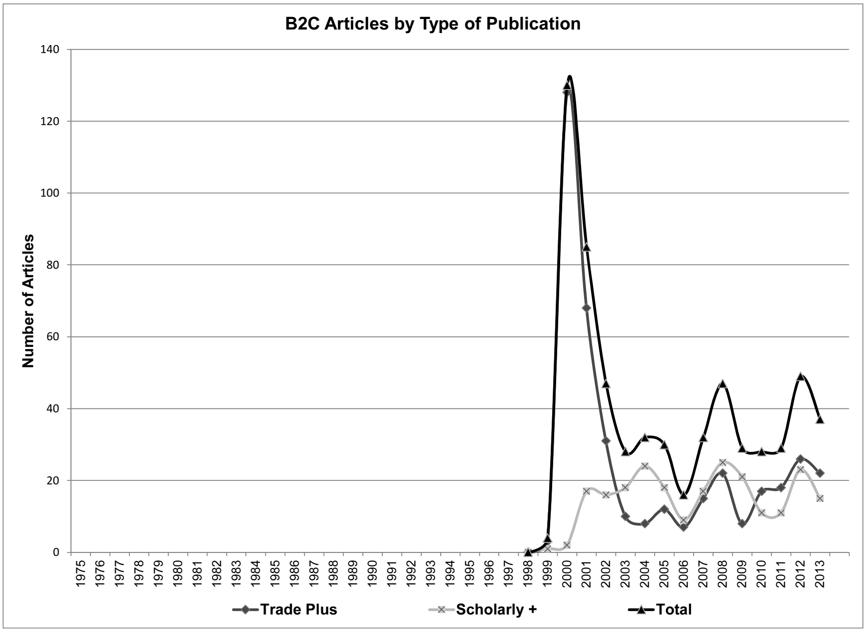

Figure 11C.1. Total number of B2C articles.

History (Time Line, Reasons Originated, Principal Developers)

B2C programs became popular during the 1990s as a multitude of companies entered the E-Business arena with high hopes. Many were disappointed and failed to survive. Two notable exceptions were Amazon and E-Bay. Amazon fits the B2C format, while E-Bay is more of a C2C business, in which individuals sell to other individuals.

Figure 11C.1 shows the number of B2C articles started just before the Y2K period. The quantity exploded during 2000 and 2001, and has since fallen to a fairly stable volume during the past eight years. Whereas B2C articles were largely in trade journals (over 80%), scholarly articles make up about one-third of the B2C articles.

While many of the early B2C businesses were strictly online, there are an increasing number of retail businesses that are adding an online selling capability to their traditional storefronts, especially those in relatively small and less costly products—books, clothing, small appliances and music.

Expected Benefits (Tangible and Intangible)

The benefits to the business are lower investment costs (clicks instead of bricks), greater product offerings, wider accessibility to consumers, and the allure of advanced technology. The benefits to the consumer are lower costs, greater selection, at-home convenience and the fascination of using advanced technology.

With the continued growth of B2C, online vendors are providing an increasing array of services that support and enhance their core products or services. Amazon does not just sell books; it also enhances that core product with automated product recommendations, "wish list" tracking, order status updates, customer reviews, and other valuable supporting services. These supporting services result from advances in information technology that seamlessly link website design with order handling and delivery processes (Cenfetelli, Benbasat, & Al-Natour, 2008).

Barriers to Acceptance

The greatest barrier to more rapid increases in B2C selling is the level of consumer trust in buying online, especially in using credit cards or other forms of payment, especially before delivery of the product. B2C sellers find it is necessary to establish credibility with consumers before they can expect to do business with them.

B2C e-commerce suffers from consumers' lack of trust. This may result from the lack of face-to-face interpersonal exchanges that provide trust behavior in conventional commerce (Aldin, Hobbes, & Qahwaji, 2008). Gefen & Straub (2003) and Holsapple and Sasidharan (2005) concur that the lack of social presence in B2C websites may lead to a lower propensity to buy. After the technology problems have been solved, lack of trust is often a significant barrier to successful implementation.

What starts out as a relatively simple, or straightforward, business may soon become more complex if the business is to become profitable. Amazon started as a book seller, expecting they could operate without having their own distribution centers. They soon found they needed more control over their distribution process to assure a high level of customer satisfaction. They also decided to add other product lines to their website, in order to achieve a higher level of volume and move them into a profitable situation (Pandya & Dholakia, 2005).

Implementation Approach

For an initial startup, Jones, Spence and Vallaster (2008) offer the following steps:

- Design and establish a website. Although this may appear obvious, not any website will do. In addition to being functional, it must display emotion-causing features such as vividness, interactivity, challenge, interaction speed, machine memory, and allowable social interactions, if it is to effectively attract buyers.
- Decide on a product line and support services. Some products sell readily over the Internet, such as books, music, and clothing. They are relatively low cost and well known to consumers. On the other hand, automobiles and major appliances do not move as well because the consumer still wants to examine them more closely before buying. Support services need more than a help line. These services should be designed as carefully as products to meet customer needs and wants.
- Establish a supplier network for selected product lines. Some B2C businesses started with the concept they would receive the order from the individual consumer, record the order, send it to their supplier, and the supplier would send the item to the consumer. Many of these businesses found it necessary to establish their own distribution centers to house the most popular items to be sure of having fast response times for their customers.
- Establish the infrastructure needed to deliver the goods and services. In order to effectively connect with customers and suppliers in a supply chain, the focal company must establish an appropriate organization structure, select and train qualified employees, and establish processes to accomplish the tasks needed to carry on the business.
- Establish a company-consumer interface that works and does not drive customers away. Quickly, the company must move from a customer acquisition phase to a customer retention phase in their progression. B2C businesses depend on repeat business and referrals to build trust between themselves and their customers.
- Prepare a test marketing plan to attract a select group of consumers. First impressions and initial successes are important. Design a test marketing plan that has a high probability of success and test it on an attractive market segment. Success in the early stages provides the opportunity to build on in later stages.
- Initiate the test plan and evaluate. It is unlikely that everything will work exactly as planned in the test phase. Evaluate the results and adjust as necessary to increase the likelihood of future success.
- Establish credibility with the marketplace, especially in availability and delivery of goods. In the early stages of a product life cycle, or a new technology, it is most important to assure the marketplace

that you have a product that not only works but is also readily available. Availability implies convenient and timely delivery.

- Redesign and implement on a broader scale. In a rapidly changing industry such as an online business, it is expected that changes in the processes will be necessary. While success in the early stages is encouraging, the marketing landscape changes, and supply processes must change accordingly.

For a company with existing retail stores, in addition to all of the steps outlined above to get their B2C business started, they need to design a program to assure compatibility of the online program with the existing retail operation. B2C e-commerce has emerged through a creative destruction process whereby it expands at the expense of traditional retailing. Consequently, addressing the e-commerce trend becomes a strategic imperative for traditional firms. Conversely, in digitally unrelated sectors, *B2C* e-commerce has emerged through a new niche formation process whereby *B2C* e-commerce coexists with traditional retailing; thus, embracing the e-commerce trend becomes the traditional firms' strategic choice (Tangpong, Islam, & Lertpittayapoom, 2009).

Although a B2C business may have started with strategy based upon the idea of technology leadership, they will eventually migrate through interim stages to a market strategy. Only then will they be capable of yielding sustainable, consistent *e*-business profits (Willcocks & Plant, 2001).

Future

Many B2C businesses started with technology as the driver. However, as the business matures and prospers, a different view is that the marketing task has moved beyond being transaction- or relationship-driven, and that it can and should increasingly often be viewed as an information-handling problem (Holland & Naude, 2004)

As part of the movement toward considering B2C as marketing-oriented, there is an increasing interest in personalization. Some consider personalization to be a critical component of B2C businesses (Koutsabasis, Stavrakis, Viorres, Darzentas, et al., 2008).

Kumar (2007) carries it a step further by describing the movement from mass customization to mass personalization as a strategic transformation enabled by the following underlying factors:

- Development of information technologies such as peer to peer (P2P), *business* to *consumer* (*B2C*), and Web 2.0,

- Near-universal availability of the Internet,
- Customer willingness and preparedness to be integrated into the process of product co-design and co-creation,
- Modern manufacturing systems, such as flexible manufacturing
- Mass customization tools such as modularity and delayed differentiation, which help reduce manufacturing cost and cycle times
- Deployment of customer-satisfaction-specific software called customer relationship management (CRM) to engender customer retention.

While it is easy to assume that the B2C concept will grow rapidly and extend well beyond its present application areas, it is not so easy to chart a specific path it will follow. Some changes will be incremental and smoothly assimilated within the ongoing programs. However, it is likely that there will be some disruptive technologies and concepts that have not yet taken form.

A number of "bricks and mortar" retail stores are moving to become "bricks and clicks" retailers where they offer omnichannel services. Shopping, buying and deliveries can be any combination of online or in-store service the customer wants. For a fuller discussion of this trend, see Crandall (2014).

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CHAPTER 11D

AUTOMATIC IDENTIFICATION SYSTEM (AIS)

NAME AND BRIEF DEFINITION

Automatic identification system (AIS)—A system that can use various means, including bar code scanning and radio frequencies, to sense and load data in a computer (Blackstone, 2013).

Automatic identification and data capture (AIDC)—A set of technologies that collect data about objects and then send these data to a computer without human intervention. Examples include radio frequency wireless devices and terminals, bar code scanners, and smart cards (Blackstone, 2013).

Radio frequency identification (RFID)—A system using electronic tags to store data about items. Accessing these data is accomplished through a specific radio frequency and does not require close proximity or line-of-sight access for data retrieval. See: active tag, passive tag, semi-passive tag (Blackstone, 2013).

Automatic identification systems (AIS) have been closely associated with bar codes for several decades and the use of bar codes is well known. A newer technology, RFID, is also a form of AIS that is gaining popularity and will be the basis of this description of AIS systems.

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Objectives (Reasons for Adopting Program)

The use of RFID will enable organizations to collect, analyze and use data better. RFID tags are designed to replace bar codes, primarily because more data can be placed on a RFID tag than on a bar code. This added data capacity will make it possible for users to compile more information about product history and traceability, customer preferences, demand patterns, and other relevant facts. Advocates believe RFID will improve customer service by better matching supply with demand. It should also reduce costs through improved inventory management and avoidance of obsolescence and waste.

The technology is still relatively expensive, compared to bar codes, and many CEOs appear to have refrained from making the necessary investment, waiting to see whether it wins rapid adoption. Chances are getting better that it will. Improving on traditional bar-code technology, RFID uses radio signals to read and transmit data from electronic tags placed on pallets of goods or even on individual pieces of merchandise, giving companies an unprecedented tool for turbocharging a variety of inventory-management, supply-chain and security functions (Buss, 2004).

History (Time Line, Reasons Originated, Principal Developers)

Radio frequency identification (RFID) has been a subject of much discussion in recent years. Opinions range from glowing optimism to marginal acceptance. While almost all writers hold out hope for the long-term success of this technology, there is growing skepticism about the short-term. Consider the following:

In 1996, Ian Byfield reported that "RFID has therefore moved from being regarded as a novel technology, useful in carefully selected areas, towards gaining the growing reputation in industry in general that it represents a reliable and cost-effective means of identification across a wide range of applications.… The range of features which such tags will offer in the future is almost impossible to predict" (Byfield, 1996).

Clyde Witt of Material Handling Management magazine, says, "Radio frequency identification (RFID) is becoming the technology of choice for identifying and tracking goods, but making the transition from current legacy systems to new processes is the challenge facing material handling managers. The migration point from the old processes to the new is data integrity" (Witt, 2000).

In 2003, Computerworld reported "Executives from several large companies last week outlined their plans to move ahead with RFID technology as a replacement for bar codes. But there are formidable obstacles to the technology's widespread adoption, they said. At the inaugural Electronic Product Code Executive Symposium held here last week, users said it will take five to 10 years for radio frequency identification technology to be fully deployed at the individual item level" (Vijayan, 2003).

The Auto-ID Center at Massachusetts Institute of Technology announced the launch of version 1.0 of the EPCGlobal Network in September 2003. This was a key milestone in the launch of a global set of standards and technologies that allow individual items to be tagged with microchips or radio frequency identification tags. These tags carry the electronic product code, which allows these objects to be uniquely identified and, through wireless technology, detailed information to be maintained on the object. Thus, the products on the shelf can not only talk to you, they have a distributed memory (Doyle, 2004).

In 2004, the Wall Street Journal reported that, "Though the vision is eventually to replace the ubiquitous product bar codes with these radio ID tags—which provide more information faster and with less labor—right now Wal-Mart is asking only that its suppliers use the technology at the warehouse level to tag packing cases and pallets destined for three Dallas distribution centers. But Wal-Mart won't allow its suppliers to pass through the added costs of radio ID technology. Instead, it says they must find ways to use the technology that produce offsetting savings" (Warren, 2004).

A more recent survey of manufacturing and service companies found that, while RFID technology does not directly impact supply chain performance, it does lead to improved information sharing among supply chain members, which in turn leads to improved supply chain performance. The researcher points out that the survey results should be tempered because RFID is still in the introductory and growth stages of the technology utilization life cycle. In view of the early results, practitioners should expect improved customer satisfaction through the implementation of RFID technology and the information sharing the technology facilitates (Zelbst, 2010).

For a comprehensive review of the evolution of RFID and other applications in apparel retailing, food and restaurant, healthcare, logistics, travel and tourism, libraries, higher education and the military, see Zhu, Mukhopadhyay, and Kurata (2012).

John Hill (2013), one of the pioneers in the RFID movement, reports that the latest report, from IDTechEX Research, on the RFID market suggests that global revenues will increase from about $7 billion in 2012 to $23.4 billion in 2020, including tags, readers, software and services. The growing applications in manufacturing and the supply chain include: Work-in-process and pedigree tracking; smart cabinets; inventory management; pharmaceutical tracking; airline baggage handling; reusable

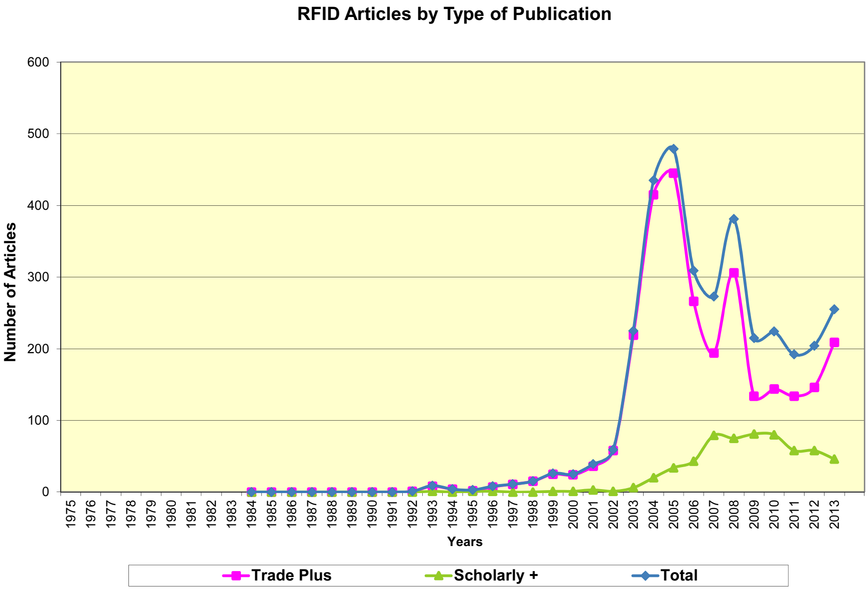

Figure 11D.1. Number of RFID articles by type of publication.

containers including ocean container identification; fixed and mobile asset tracking; and high-value item identification (particularly apparel).

Other applications beyond the supply chain, and representing the bulk of the projected revenue, include access control, livestock and pet tracking, highway toll collection, contactless smart cards, passports, patient and asset tracking in hospitals, smart tickets, vehicle immobilizers, as well as financial and other security uses (Hill, 2013).

Figure 11D.1 shows the number of articles about RFID. Beginning in the late 1980s, the number of articles increased rapidly in the early part of this century and then began to decline about 2005. While the number of total articles being published about RFID is decreasing in total, the number written for academic journals is increasing, indicating a building interest in examining RFID applications more closely. In general, the number of applications is increasing, as organizations of all types find ways in which the advantages of RFID can be adapted to their needs.

Expected Benefits (Tangible and Intangible)

In 2001, a Sunnyvale, Calif., pharmacist discovered that bottles of Neupogen, an expensive growth hormone prescribed for AIDS and cancer patients, was filled only with saltwater. With radio labels, a company will be able to trace those bottles to individual pharmacies. "If that pharmacy was robbed, we'll know for certain that that guy is in possession of stolen property," Mr. [Aaron Graham] said. Radio labels could conceivably help ensure that imported drugs are safe, Mr. [William Hubbard] of the F.D.A. said. But drug manufacturers are unlikely to put radio labels on drugs sold in other parts of the world for many years, he said. The F.D.A. has been a fierce opponent of legalizing drug imports (Harris, 2004).

SAP's RFID solution was developed and built entirely from the ground up to help companies manage data reads-from and writes-to RFID tags, company officials say. Drawing on experience from customer projects with companies like Procter & Gamble and the METRO Group as well as six years of RFID research and involvement in RFID standards organizations, SAP has developed technology it says will change supply chain management dramatically in the retail and consumer product industries. Companies can leverage data captured through RFID tags in their business processes by integrating ERP and SCM functionalities with RFID-enabled applications. Examples include packing and unpacking, shipping and receiving, and tracking and tracing across the supply chain. SAP has been conducting RFID research since 1998, and its RFID Customer Council has been working closely with more than 60 companies from the consumer products, pharmaceutical and retail industries for almost a year (Boone, 2004).

Accurate knowledge of inventory could help avoid stockouts, increase inventory turns and reduce ordering lead times. As a result, this would lower labor costs, simplify business processes and improve supply chain efficiency. (Zhu, Mukhopadhyay, & Kurata, 2012)

Barriers to Acceptance

In his classic book, Diffusion of Innovations, Rogers offers a number of reasons why innovations are difficult to successfully implement. (Rogers, 2003) How do we move through the phases outlined by Rogers? We need to continue to educate (Knowledge) and evaluate (Persuasion) how to move through the barriers still confronting the program. Some of these barriers include:

- Lower read rates than for bar codes
- Higher costs per tag than for bar codes
- High investment costs for readers and infrastructure
- Lack of universal standards
- Lack of inter-company data communication compatibility

These are technology issues, and companies and associations are working diligently to solve these problems. Although the most optimistic advocates expect the solutions will require multi-year programs, they are confident of eventual success.

However, other non-technology issues have not been resolved. Trust among supply chain members presents a formidable barrier. Whom do we trust? How much? Even if we trust our suppliers, how secure is our data when it's moving through cyberspace? Will our trusted suppliers today become our feared competitors tomorrow? If businesses are concerned about trust and privacy issues, what about the general population who hear of embedded RFID tags by which a company or the government can track their every move? It's not the reality; it's the perception of reality that so often matters.

In addition to the trust and privacy issues, the economic issues are real. What will be the return on our investment? How long will it take to realize it? Even if it benefits our supply chain members, will we get our share? Should we do just enough to satisfy the mandate, or should we go all out and hope for the best? Will we have to maintain both RFID and bar code systems to meet the requirements of a mixed group of customers? How long will it be before everyone will switch to RFID? These, and other questions, will haunt decision-makers for some time to come. From (Crandall, 2005a).

Some of the issues related to RFID adoption include:

- Difficulty in calculating the potential ROI
- Difficulty in allocating costs and benefits along the supply chain
- Variation in response to mandated use by dominant member of the supply chain
- Technical issues include reader and tag collision (signal interference or multiple reads) and privacy concerns (Zhu, Mukhopadhyay, & Kurata, 2012).

RFID, like other technologies, has the potential to affect business process efficiency and effectiveness as well as product and service value. But depending on what part of an organization or supply chain leads the effort and the operating condition of the firm, this potential may never be realized. The risk that many firms face is simple: They must be prepared to take advantage of the faster acquisition and transmittal of data that RFID promises. Specific risks include: (1) An RFID system may actually trigger the fast and efficient replenishment of products that customers don't actually want at full price; and (2) RFID may facilitate only the local optimization of a system (Rappold, 2003).

Much of the focus surrounding RFID costs has been on chip or tag prices. But implementing a fully functional system incurs multiple costs, including tags, readers, printers, middleware, infrastructure, consulting, research and development, system changes, implementation, training, change management, service-provider fees, and additional labor. For early adopters, it's likely that implementations will prove more costly in the beginning stages given the likelihood of first-time mistakes and the lack of industry-best practices. In most cases, companies are looking at investments that can easily reach into millions of dollars. The cost of technology infrastructure to support and manage RFID-related data will depend on the number of locations for deployment, environmental conditions, and other complexities (Schutzberg, 2004).

Although progress has been made in reducing tag cost, it is still a barrier for lower-priced consumables, such as boxes of cereal or candy bars (Hill, 2013).

Implementation Approach

Perhaps we need to consider what researchers have discovered about the diffusion of innovations, and certainly, RFID qualifies as an innovation. Dr. Everett Rogers has spent a lifetime studying the diffusion of innovations in a variety of situations and research disciplines. (It is interesting that less than 20% of the studies have been in business settings.) The latest (fifth) edition of his book *Diffusion of Innovations* is a travelogue through the history of innovation diffusion research. Among a number of interesting conclusions about this field, Rogers warns us that the diffusion of innovations is a complex process involving not only the technology of the innovation but also the acceptance of the innovation by the intended users. It can be a long process and success is not always guaranteed, despite the brilliance of the innovation.

How do we reconcile what has happened with RFID with other innovations? While it is obvious to most who have written about the RFID technology that it is superior to bar codes in many ways, there is yet to be a rush to implement RFID systems, especially among manufacturers, who will bear most of the costs for the new systems. We are a long way from achieving the "critical mass" (Rogers, 2003) necessary for RFID to become the accepted data collection medium so many envision.

Rogers proposes a general model for innovation diffusion with the following phases:

- Knowledge (we learn about it),
- Persuasion (we accept it as useful to us),

- Decision (we decide to try it),
- Implementation (we try it, at least in a pilot test) and
- Confirmation (we like it and continue to use it).

At best, we appear to be in the Persuasion phase with RFID. While a few users are convinced that its time has come (these are the innovators in Roger's world who represent 1–2% of the eventual user world), most businesses are proceeding somewhat reluctantly toward mandated deadlines, the most notable being imposed by Wal-Mart and the Department of Defense (Crandall, 2005b).

Future

So what does Rogers suggest? In a nutshell, he tells us that we must have the correct infrastructure to move the innovation forward. (Rogers, 2003) The "innovators", such as Wal-Mart and the Department of Defense, need help from the "change agents", such as the hardware and software developers, and the consultants who are truly knowledgeable about the needs and applications for RFID. However, the key to eventual success will be the "opinion leaders" (the early users) of the industries in which RFID will be used. These opinion leaders will be the materials managers who manage the inventories, the IT managers who communicate and manage the data, the financial managers who fund the investments, the marketing managers who analyze the enormous amounts of data that will be flooding the implementers of RFID, and the materials handling systems managers that move the product from origin to destination. Think about it: When you really want to know about how effectively something works, do you call the salesperson who sells that item, or do you ask a colleague that is using that item? Until the opinion leaders of the RFID world place a stamp of approval on RFID, it will remain a vision, not a reality.

Rogers is not a pessimist; he is a realist who has learned, through his 40 plus years of studying innovation diffusion, that technology is great, but it is the people, both the developers and the users that make it work. When the innovators and change agents convince the opinion leaders of RFID's value, the movement will move ahead with increasing momentum until it reaches a critical mass of applications, and take its place as a successful innovation. Otherwise, it will meander along, gathering momentum more slowly, and will eventually achieve its place in the history of innovations, but a place well short of its potential (Crandall, 2005).

Data synchronization is moving forward but much remains to be done, both in the United States and globally. Companies must continue to drive implementation of data standards, item registry, and data synchronization. This must remain a top priority even as new collaboration-enabling technologies, such as Radio Frequency Identification (RFID) and the Electronic Product Code (EPC), begin to take center stage. Without Global Data Synchronization (GDS), the future of collaborative technologies, including EPC, is uncertain. (A. T. Kearney, 2004).

Should an organization move to RFID? Hill (2013) suggests developing answers to the following questions before making the change.

- Where are the benefits for your operations? Quantify and put a value on them.
- What is your gross margin on shipments today? What will that margin be with the introduction of RFID, including the expected value of internal benefits?
- Does it make sense from this perspective to move forward?
- What are the consequences of delay?

If the answers to these questions are favorable, or if retaining a valued customer demands it, begin planning the implementation in a deliberate and realistic way.

The RFID Journal (2014) is a major source of information about RFID applications by industries—aerospace, apparel, consumer packaged goods, defense, health care, logistics, manufacturing, pharmaceutical, and retail. The site also has “how-to” information and reports on current events related to RFID.

ACKNOWLEDGMENT

A portion of the description of this program has been adapted from Crandall, R. E. (2005). The tipping point for RFID. *APICS Magazine, 15*(3), 14–16.

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CHAPTER 11E

DECISION SUPPORT SYSTEM (DSS)

NAME AND BRIEF DEFINITION

Decision support system (DSS)—A computer system designed to assist managers in selecting and evaluating courses of action by providing a logical, usually quantitative, analysis of the relevant factors (Blackstone, 2013).

The primary components of a DSS include:

- A database—to make available facts for use in the decision model
- A model—to manipulate the data into meaningful information
- A display—to convey information to the decision maker

While a computer system is the backbone of the DSS, it requires cross-functional teams to build the database and model that is unique to the decision areas supported.

Objectives (Reasons for Adopting Program)

The primary objective of a DSS is to assist, or support, a manager in making a better, and more timely decision than would have been made without the help of the DSS. Routine, or structured, reports often do not

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help because they may contain too much data, in the wrong form, or too late to be useful. DSS systems are designed to provide relevant information, in a timely manner, and in a format that is easy to understand.

A DSS is most useful when dealing with semi-structured and unstructured data. It is a way to assist the decision-maker; if the decision is made by the system without interaction with a person, it is not a DSS (Pick & Weatherholt, 2013).

History (Time Line, Reasons Originated, Principal Developers)

In the 1960s, researchers began to study the use of computerized quantitative models to assist in decision making and planning. A major milestone was Michael S. Scott Morton's dissertation field research in 1967 that involved building, implementing and then testing an interactive, model-driven management decision system. The first use of the term "decision support system" was in Gorry and Scott-Morton's (1971) Sloan Management Review article. They argued that Management Information Systems (MIS) primarily focused on structured decisions and suggested that the supporting information systems for semi-structured and unstructured decisions should be termed "Decision Support Systems." The pioneering work during the 1950s and 1960s of George Dantzig in linear programming, Douglas Engelbart in data storage and retrieval, and Jay Forrester in simulation models, likely influenced the feasibility of building computerized decisions support systems (Power, 2007).

Watson and Marjanovic (2013) explain that the coming of big data introduces a new generation of DSS. In fact, they claim that big data will be the fourth generation of data management. The first generation was the traditional DSS; the second was enterprise data warehouses; and the third was real-time data warehousing. These generations are characterized by scope, focus, decisions supported, users, volume, velocity, variety, data sources, architecture complexity, and value. The authors add that "each generation was driven by business need, fueled by technological advances, and faced many implementation challenges" (Watson & Marjanovic, 2013, p. 4).

Figure 11E.1 shows the number of articles published each year for the search keywords of "decision support systems" and "DSS." Although there were earlier articles, the DSS acronym probably wasn't in common use until the late 1970s. The total number of articles peaked in the mid 1980s, declined until about 2000, and increased in recent years. However, most of the recent increase is in scholarly articles, as the interest in trade publications has been minimal except for a burst of interest in the early

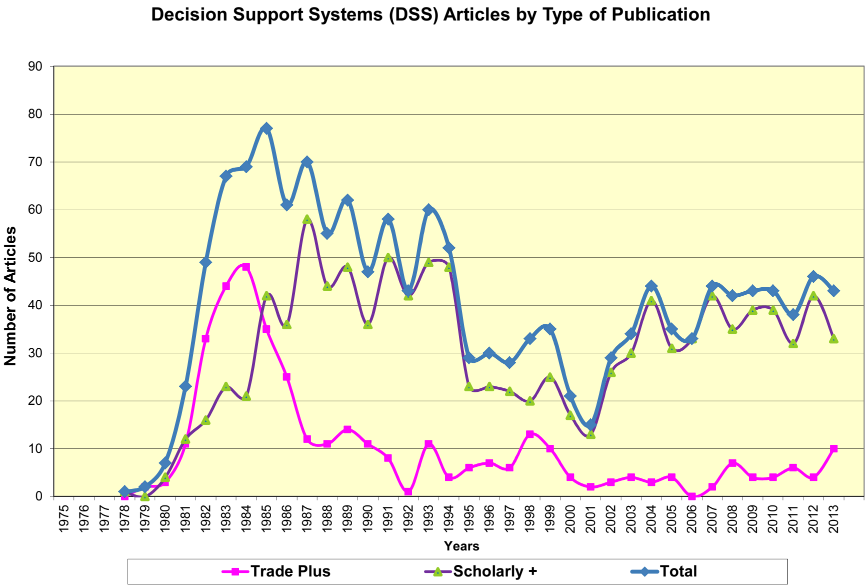

Figure 11E.1. Total number of DSS articles by type of publication.

1980s. The interest from scholars is likely the result of heavy emphasis on computer models and quantitative analysis methods commonly associated with DSS.

Eom and Kim (2006) conducted a survey of journal articles for the periods from 1995–2001 to determine the type of DSS applications and the tools used in the applications. This study was a follow-up to two previous studies that covered the periods from 1971–1994. In the third study, they found the application areas as shown below:

Corporate functional management (154 articles)

- Inter-organizational decisions (2%)
- Strategic management (4%)
- Human Resources (4%)
- Finance (6%)
- Multi-functional application (8%)
- MIS (14%)
- Marketing/Transportation (18%)
- Production/Operation (44%)—aggregate demand and product planning, capacity/product planning (fixed and adjustable), master

scheduling, operations design, scheduling and controlling, inventory management, resource management, and others).

Non-corporate areas (56 articles)

- Agriculture (7%)
- Urban/Community Planning (7%)
- Military (11%)
- Natural Resources (13%)
- Hospital/Health care (13%)
- Misc. (14%)
- Education (16%)
- Government (20%)

They also looked at the tools used in the studies, which included deterministic models, stochastic models, forecasting and statistical models, and others—graphics, artificial intelligence, visual interactive modeling and a variety of internet-related tools.

Although traditional quantitative models continue as popular tools for DSS, a number of new tools, such as Geographic Information systems (GPS), object-oriented methodologies (modeling, programming and database), intelligent agents, World Wide Web technologies, and other internet technologies are rapidly gaining in popularity (Eom & Kim, 2006).

Power (2007) provides the following classifications of DSS applications:

- Model-driven DSS—emphasizes access to and manipulation of financial, optimization and/or simulation models.
- Data-driven DSS—emphasizes access to and manipulation of a time-series of internal company data and sometimes external and real-time data.
- Communications-driven DSS—use network and communications technologies to facilitate decision-relevant collaboration and communication.
- Document-driven DSS—uses computer storage and processing technologies to provide document retrieval and analysis.
- Knowledge-driven DSS—can suggest or recommend actions to managers, such as with expert systems
- Web-based DSS. Beginning approximately 1995, the World-wide Web and global Internet provided a technology platform for fur-

ther extending the capabilities and deployment of computerized decision support.

DSS continue to use new technology developments in very large data bases, artificial intelligence, human-computer interaction, simulation and optimization, software engineering, telecommunications and behavioral topics like organizational decision making, planning, behavioral decision theory and organizational behavior (Power, 2007).

Expected Benefits (Tangible and Intangible)

The obvious expected benefit is that better decisions will be made, resulting in lower costs, higher revenues, increased return on investment, or other tangible favorable results. In addition, an intangible benefit is that decision-makers will become better decision-makers. As globalization and dynamic changes in the marketplace become more common, it is imperative that decisions will be required faster, with insufficient information available. This means that DSS will have to be redesigned to reflect these changing conditions. However, it also means that human beings will have to continue to rely on their experience and judgment, with DSS providing support, but not the automatic decision.

Pick and Weatherholt (2013) discuss a number of DSS systems that have provided benefits over several decades. They classify the systems as follows:

- Communications-driven DSS—Systems where the driving technology is a facilitation of interpersonal communications.
- Data-driven DSS—Those systems for which the underlying driving technology is a large stored databank.
- Document-driven DSS—This type of system provides the decision-maker with relevant information from a store of documents.
- Knowledge-driven DSS—These systems use a knowledge base extracted from the tacit knowledge of an expert.
- Model-driven DSS—The driving technology is one or more mathematical model(s). Examples of models might be built around simulation or optimization models.
- Graphics-driven DSS—This type of system is primarily driven by the ability to display data meaningfully to decision-makers.

While it is clear that DSS continue to be useful, it is evident they are becoming more diverse and multi-faceted, especially as data enters the Big Data era.

Barriers to Acceptance

The most obvious barrier to the effective use of DSS is that the intended user of the system is not involved in its design. It is not enough that the DSS is carefully designed; it must fit the needs of the decision-maker. In the early days of DSS development, Eric Carlson (1977) speculated that the computer technology required was being rapidly developed and that it would enable, and require, different uses. He also said, "But because many managers know what representations, operations, memories, and methods of control fit their styles of decision making, management involvement will be more important than computer technology in developing useful decision support systems." Another early writer reported that too often, managers have little say in the design and development of the DSS, while those who design the system have a limited understanding of how they can be used (Alter, 1976). As recently as 2009, Thomas Davenport reported that too many analytical models are being designed that managers don't understand.

Another barrier is the difficulty in designing a DSS that works. It must incorporate all of the key decision variables, provide the needed information seamlessly, and quickly manipulate the data in a way that enables the manager to decide on a course of action within the allowable time constraints. The system must apply directly to the decision space and it must be updated continuously to reflect the latest decision parameters. The design requires good technical knowledge as well as the managerial knowledge described in the previous paragraph; this demands the collaboration of cross-functional teams.

It is difficult to justify the cost of a DSS. How much better decisions are made as a result of using the DSS? While there may be some benefits, they are not easy to quantify. As with many projects associated with the design of information systems, the costs can be significant and are often expended well before there are any benefits, either tangible or intangible.

Just as there is a cost to designing a DSS, there is a cost associated with maintaining it. For example, suppose the manager for which the system was designed is promoted or leaves that position for some other reason. Does that mean the new manager must use the system as designed or must the system be reworked to fit the new manager? In addition, there are always new variables to be considered; this may require a change in the underlying algorithms or rules. Hopefully, the design was documented well enough to enable the new design specialist to figure out how to make the modification.

Implementation Approach

The basic implementation steps for designing the DSS include:

- Decide on the decision to be made
- Decide who will make the decision (may involve a multi-function team)
- Involve the decision-makers in designing the DSS
- Decide what information is needed to make the decision
- Decide where to get the information
- Decide the criteria to be considered in making the decision

The basic steps for using the DSS include:

- Develop alternative decisions
- Select the best alternative
- Evaluate best and worst case scenarios for the alternative selected
- Develop the strategies necessary to implement the decision
- Assign responsibilities
- Follow up to assure successful implementation of the decision

Future

Trends suggest that data-driven DSS will use faster, real-time access to larger, better integrated databases. Model-driven DSS will be more complex, yet understandable, and systems built using simulations and their accompanying visual displays will be increasingly realistic. Communications-driven DSS will provide more real-time video communications support. Document-driven DSS will access larger repositories of unstructured data and the systems will present appropriate documents in more useable formats. Finally, knowledge-driven DSS will likely be more sophisticated and more comprehensive. The advice from knowledge-driven DSS will be better and the applications will cover broader domains (Power, 2007).

The advent of big data poses a quandary for the Management Information Systems (MIS) functions within organizations. The role of MIS consists of the following subsystems:

- Transaction Processing Systems (TPS): Systems to capture internal (as well as external) data about performance measures to be reported to corresponding managers

- Management Reporting Systems (MRS): Reporting systems to provide key performance indicators for each manager at all managerial levels and in all functional areas
- Decision Support Systems (DSS): Systems to help with root cause analysis, problem solving, planning, and decision making to effect changes to get back on course when a performance measure is not being met (Dadashzadeh 2013, p. 235).

Dadashzadeh (2013) points out that big data and predictive analysis has not always been considered an MIS function; however, the author believes that the MIS function should become a full participant in the big data revolution.

A sampling of the articles listed in 2009 by ProQuest (ABI/Inform) search engine included varied applications, such as strategic warehousing decisions, railroad transportation systems, urban sustainability and building energy efficiency, purchasing management, land use planning, vehicle routing for a public utility, machine scheduling and inventory management, and service quality in wireless networks. There is still an active interest in the application of DSS models to the decision-making process.

At the same time, some prominent writers do not believe that DSS has lived up to its promise. Thomas Davenport (2009) cautions that, "Traditionally, decision making in organizations has rarely been the focus of systematic analysis. That may account for the astounding number of recent poor calls, such as decisions to invest in and securitize subprime mortgage loans or to hedge risk with credit default swaps. Business books are rich with insights about the decision process, but organizations have been slow to adopt their recommendations." He goes on to suggest the following steps to improve decision making:

1. List and prioritize the decisions that must be made;
2. Assess the factors that go into each, such as who plays what role, how often the decision must be made, and what information is available to support it;
3. Design the roles, processes, systems, and behaviors your organization needs, and
4. Institutionalize decision tools and assistance.

Davenport stresses that leaders should bring multiple perspectives to their decision making, beware of analytical models that managers don't understand, be clear about their assumptions, practice model management, and—because only people can revise decision criteria over time—cultivate human backups.

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CHAPTER 11F

INTERORGANIZATIONAL SYSTEMS (IOS)

NAME AND BRIEF DEFINITION

An interorganizational system (IOS) is one which allows the flow of information to be automated between organizations in order to reach a desired supply-chain management system, which enables the development of competitive organizations. This supports forecasting client needs and the delivery of products and services. IOS helps to better manage buyer-supplier relationships by encompassing the full depths of tasks associated with business processes company-wide. In doing these activities, an organization is able to increase the productivity automatically; therefore, optimizing communication within all levels of an organization as well as between the organization and the supplier. For example, each t-shirt that is sold in a retail store is automatically communicated to the supplier who will, in turn, ship more t-shirts to the retailer. Organizations might pursue an IOS for the following reasons:

1. Reduce the risk in the organization
2. Pursue economies of scale
3. Benefit from the exchange of technologies
4. Increase competitiveness
5. Overcome investment barriers
6. Encourage global communication

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The most common form of IOS is electronic data interchange, which permits instantaneous computer-to-computer transfer of information (Wikipedia, 2014). Turban et al. (2006) defined an interorganizational system (IOS) as a system that involves information flow among two or more organizations. They were developed as a result of two business pressures: the desire to reduce costs, and the need to improve the effectiveness and timeliness of business processes.

Chi and Holsapple (2005, p. 55) provide a basic definition of interorganizational systems (IOS). "In the broadest sense, an IOS consists of computer and communications infrastructure for managing interdependencies between firms. From a knowledge management perspective, this infrastructure enables and facilitates knowledge flows among organizations (and their participating representatives) such that the needed knowledge gets to the relevant participants on a timely basis in a suitable presentation(s) in an affordable way for accomplishing their collaborative work."

Interorganizational systems (IOS) can be considered as planned and managed cooperative ventures between otherwise independent agents (Kumar & van Dissel, 1996). They point out the move from competition to collaboration is a relatively new concept. Their basic premise is that, while IOSs are beneficial, the relationships between entities have to be nurtured to remain successful. An IOS includes some technical elements. Turban et al. (2006) lists these as:

Electronic data interchange (EDI)—the electronic movement of business documents between business partners. EDI was one of the first functioning IOS technologies and first came into prominence in the 1980s. It worked well in connecting one business with another but it was expensive to install and operate. As a result, large companies were able to achieve benefits while smaller companies were not able to economically justify the investment. In recent years, the use of the internet in providing a communication system is gaining in popularity and holds promise for businesses of all sizes.

Extranets—extended intranets that link business partners. The extranet is one way in which companies are beginning to use the internet in their IOS. Extranets use virtual private network (VPN) technology to assure security in communications. They are less costly than using conventional EDI and provide a way for a group of related companies to work together, such as a company and its dealers, an industry consortium, a joint venture or a virtual company.

XML—an emerging B2B standard, promoted as a companion or even a replacement for EDI systems. XML, when compared with EDI, is more flexible, is more easily read and understood, and requires less specialized knowledge. Now, however, potential drawbacks are lack of universal XML standards, lack of experience in XML implementation, and sometimes less security than EDI.

Web services—the emerging technology for integrating B2B and intrabusiness applications. One of the real difficulties in implementing IOSs is getting compatibility between computer systems in different entities. Getting our system to talk with your system is almost as difficult as getting our people to talk with your people. One area that is getting a lot of attention these days is service-oriented architecture (SOA), which provides a way to get disparate systems to share data and services. A recent article in the APICS Magazine illustrates the use of SOA in connection with WMS (Warehouse Management Systems) systems (Rennie, 2006).

There are several types of IOS:

- B2B trading systems—facilitate trading between (among) business partners
- B2B support systems—nontrading systems such as hubs, directories, and other services
- Global systems—connect two or more companies in two or more countries (Turban et al. 2006)

In addition to the technology, an IOS must include other necessary ingredients. The first is a worthwhile application. Companies must have a business reason to communicate with each other. While the needs may be obvious, often it is necessary to choose among alternatives. Which processes and relationships should be worked on first? The fact that it is difficult to establish a smooth-running relationship means there may be a finite number of relationships that can be successfully maintained. Consequently, it is important to choose those applications with the greatest payoff.

Once the applications have been determined, businesses must make sure they have accurate and timely information available to use in the IOS. The IOS is of limited value, and may even be a hazard, without good information to flow along the streamlined communication channels.

Finally, companies have to build relationships with one another. Relationships can be one-to-one (traditional EDI between one customer and one supplier), one-to-many (extranet from manufacturer to dealers), many-to-one (reverse auction), or many-to-many (electronic marketplace, such as an electronic hub in a supply chain configuration of suppliers and customers). However, relationships are more than a mechanical linking of computers in which a store's computer automatically orders replenishment stock. They also involve the linking of individual persons, departments and entire companies. This takes conviction and perseverance.

Objectives (Reasons for Adopting Program)

The objective of an IOS is to facilitate the communication between, and among, different entities. The implication is that the communication will be in electronic form to make it possible to reduce lag time between messages and to increase the portability and storability of information. In today's supply chain world, it is necessary to link participants together so that the information communicated facilitates the flow of goods and services, as well as smoothing the flow of funds after the goods and services have been provided.

Organizations might pursue an IOS for the following reasons:

- Reduce the risk in the organization
- Pursue economies of scale
- Benefit from the exchange of technologies
- Increase competitiveness
- Overcome investment barriers
- Encourage global communication (Wikipedia, 2010)

One of the keys to successful IOS implementations is the level of collaboration among participants. They should consider which of these motives are applicable to their situation, how they relate to relational bonding and behavioral processes, and the impacts on collaborative advantage. Chi and Holsapple (2005) offer the following motives:

- **Necessity motive**: an organization adopts the use of an IOS in order to meet necessary legal, regulatory, or deregulatory requirements form higher authorities (e.g., government agencies, legislation, industry, or professional regulatory bodies)
- **Asymmetry motive**: an organization is prompted to use an IOS for purposes of exerting power or control over other organizations
- **Reciprocity motive**: an organization uses an IOS in order to pursue common or mutually beneficial goals or interests and to facilitate collaboration, trust building, and coordination
- **Efficiency motive**: an organization is motivated to use an IOS in an attempt to improve both its internal efficiency and interorganizational efficiency
- **Agility motive**: an organization is prompted to use an IOS to increase agility and responsiveness to environmental changes
- **Innovation motive**: an organization is induced to use an IOS for purposes of innovation and value creation

- **Stability motive**: an organization is prompted to use an IOS in order to reduce environmental uncertainty and to achieve stability, predictability, and dependability in its relations with others
- **Legitimacy motive**: an organization is motivated to use an IOS to increase its legitimacy and reputation in order to appear in agreement with prevailing norms, beliefs, expectations of external constituents, or prevalence of a practice in the industry.

Although each of the eight motives may be a separate and sufficient cause for an organization's IOS adoption, the decision to use IOS is commonly based on multiple motives.

History (Time Line, Reasons Originated, Principal Developers)

In the mid-1900s, vertical integration was considered a desirable strategy because it usually offered reduced costs and greater control over the manufacturing and distribution processes, although it required a higher investment in equipment and facilities.

As IT technology became available, it was easier to develop interorganizational relationships and companies began to consider outsourcing activities that were not part of their core competencies.

Dedrick and Kraemer (2005), note that efforts to reduce costs and the efficiencies of the Dell direct-sales/build-to-order strategy were driven by competitive and market conditions. Information technology has enabled particular forms of organizational restructuring, such as the shift from supply-driven to demand-driven production and the formation of different value chains to most effectively support demand-driven production processes.

Figure 11F.1 shows the number of articles written about interorganizational information systems. Some of the articles also carried the acronym IOS. The activity level continues to increase, primarily from scholarly journals, although the total number of articles is low compared to many of the other information-related programs.

Expected Benefits (Tangible and Intangible)

IOSs were developed because of two business pressures: the desire to reduce costs, and the need to improve the effectiveness and timeliness of business processes (Turban et al. 2006). Chi and Holsapple (2005)

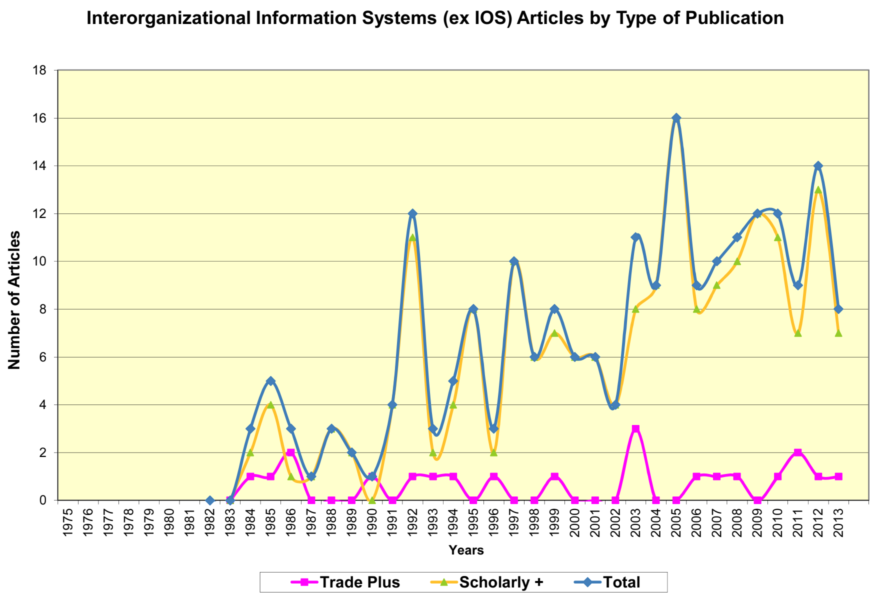

Figure 11F.1. Total number of interorganizational information system articles.

expanded the potential for IOSs by compiling the following list of benefits for IOSs:

- Become an important source of sustainable competitiveness
- Reduce cost of communication while expanding its reach (time and distance)
- Increase the number and quality of alternatives while decreasing the cost of transactions
- Enable tight integration between firms while reducing the cost of coordination
- Facilitate knowledge sharing and trust building
- Speed up expertise exploitation and knowledge application
- Enhance innovation and knowledge generation

Clark and Lee (2000) explained, "Electronic communication technologies, such as EDI, enable new forms of interorganizational coupling by overcoming barriers of time and space in linking processes between firms. Without EDI, CRP (Continuous Replenishment Program) is not economically viable, as the amount of daily information processed and transmitted in the channel is too large to handle manually."

Other motives for implementing IOSs include to comply with mandates from regulatory agencies or higher authority, to exert power over other organizations, to pursue common or mutually beneficial goals with other entities, to gain internal and interorganizational efficiencies, to increase agility and responsiveness, to promote innovation, to reduce environmental uncertainty, and to increase its legitimacy and reputation as a progressive member of its peers (Chi & Holsapple, 2005).

Barriers to Acceptance

There are a number of obstacles to the successful implementation of IOSs. The most significant ones appear to be the lack of technical standards, the resolution of relative interdependencies, and the building of trust among participants.

Technical standards. In speaking of the PC industry, Dedrick and Kraemer (2005) report, "There are few common standards across the industry, and smaller participants often have minimal IT capabilities. Creating closer links between incompatible IT systems can require costly integration via middleware and custom programming." While PCs represent only one industry, it is relatively progressive with respect to technology. Other industries no doubt have similar problems in linking systems. For a more extensive explanation of the technical issues, see Chapter 8 in Turban et al. (2006).

Interdependencies. Participation in an IOS carries with it interdependencies, ranging from casual or temporary to dedicated and lasting. Even before the modern IOS was developed, Thompson (1967) described classes of interdependencies as pooled (share common information), sequential (along the supply chain) and reciprocal (interactive between companies). Kumar and van Dissel (1996) expanded on Thompson's work by redefining IOS interdependencies as pooled information resources, value/supply chain, and networked. Chi and Holsapple (2006) compiled extensive examples for each type of interdependency.

Clark and Lee (2000) concluded that, when companies enter into an IOS, they become more dependent on each other and must recognize this; else, they may not realize the benefits. Johnson and Vitale (1988) also discuss the increase in interdependency as the IOS moves along a continuum from being a participant, to understanding a participant's business, to exploiting a participant's dependency.

Kumar and van Dissel (1996) declare that while IOSs are beneficial, entities must nurture the relationships to remain successful. They contend that their research extends the economic arguments supporting IOSs to the socio-political issues of risk and that, while IOSs are beneficial, there could be problems in the collaborative alliances.

Dedrick and Kraemer (2005) point out that the PC industry has moved toward a build-to-order (BTO) approach. This increases the complexity of an IOS to the point that it must be customized between parties. The customization increases the cost of the IOS and limits the number of IOS relationships that a company can economically sustain.

Another issue in interdependencies is who has the power. Often the initiator of the system is the customer and the supplier becomes the follower in the IOS. Riggins and Mukhopadhyay (1994) warned that suppliers who adopt IOS technology at the insistence of their customer often avoid implementing the technology in a sophisticated way. This increases the risk and may hinder not only their ability to gain benefits, but also the initiator's ability to realize many of the originally anticipated benefits.

Ownership of the IOS is another important issue. Han et al. (2004) cautions that, as companies share greater amounts of information, the risk of information exploitation increases. The owner of the IOS may expect to get information that is useful but is denied that information because of the concern of other participants. The authors conclude that while this has been an important topic in the literature, there is little guidance as to how to handle the situation.

The message is clear. IOSs provide benefits but they also raise the level of interdependence among participants, with its accompanying concerns.

Trust. IOSs require the building of relationships. Relationships breed interdependence. It takes trust among the parties involved to assure comfortable and productive interdependent relationships. Building trust is a slow and tenuous process. In their study, Chi and Holsapple (2005) determined that to achieve what they call "relational bonding," companies must first commit to making the IOS useful and then to trust their partners.

A recent study found that despite the failure to implement interorganizational information systems results in higher costs, many companies are finding that the development, implementation, and effective use of IOS remains an elusive goal. Lack of interoperability across systems is especially difficult for manufacturers with global supply chains (Steinfield, Markus, & Wigand, 2011)

Implementation Approach

IOSs evolve through several phases. Companies ideally move from a competitive standoff to a collaborative embrace; however, there are some interim stages in the evolution of an IOS.

Competition. The beginning stage is the one in which customers and suppliers compete in a zero-sum game with the objective being "I win—you lose." Other descriptors of this condition include "cards close to the vest" and "You go first."

Communication. At some point, the icebreaker is for companies to begin to communicate in a way that suggests the need and willingness to do something for their mutual benefit. They may not be convinced yet, but they begin to see the possibilities.

Coordination. As the relationship grows, the companies begin to coordinate their activities so that both will benefit. This is still a somewhat formal stage of information exchange but it does provide enough benefits that the companies are encouraged to keep going.

Cooperation. If the relationship grows into a more comfortable one, the parties involved can be more enthusiastic about the progress they are making and look for ways to make it more valuable.

Collaboration. Collaboration implies working together. At this stage, the participants are convinced that they help each other and they trust each other. This nirvana state still awaits most companies.

Future

IOS are not a dream. They exist, although not all company relationships have reached the collaboration stage. That will come as the technology, infrastructures and relationships of companies come into alignment. As supply chains expand globally and become more complex, the need for some kind of interorganizational information system becomes more important.

One of the most widely respected writers on management topics is Herbert Simon. In his view of IOS, he says: "The main requirement in the design of organizational communication systems is not to reduce scarcity of information but to combat the glut of information, so that we may find time to attend to that information which is most relevant to our tasks—something that is possible only if we can find our way expeditiously through the morass of irrelevancies that our information systems contain" (Simon, 1997).

After an extensive study of information systems in the automotive industry, Steinfield, Markus and Wiegand (2011) concluded that proprietary and point-to-point solutions are not likely to solve the need for transparency in multitiered and interconnected supply chains. They believe that this results from lack of incentives for adopting IOS, especially smaller companies, and because point-to-point systems are plagued with delays, inefficiencies, and errors. The study recommends that building IOS with industry-wide data and process standards will lower adoption costs and are more likely to solve transparency problems.

ACKNOWLEDGMENT

The description of this program was adapted from Crandall, R. E. (2007). Let's talk. Better communication through IOS. *APICS Magazine, 17*(6), 20–23. Permission requested.

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CHAPTER 11G

SERVICE-ORIENTED ARCHITECTURE (SOA)

NAME AND BRIEF DEFINITION

Service-oriented architecture (SOA)—A style of information technology (IT) design that guides all aspects of creating and using business services throughout their life cycles—as well as defining and provisioning the IT infrastructure that enables different computer applications to exchange data and participate in business processes, regardless of the operating systems or programming languages underlying those applications (Blackstone, 2013).

Service Oriented Architecture. *Service-Oriented Architecture (SOA)* is an *architectural style* that supports *service-orientation*. *Service-orientation* is a way of thinking in terms of services and service-based development and the outcomes of services. A *service* is a logical representation of a repeatable business activity that has a specified outcome (e.g., check customer credit, provide weather data, consolidate drilling reports). It is self-contained, m*ay be* composed of other services and is a "black box" to consumers of the service (Open Group, 2014).

SOA makes it easy for computers connected over a network to cooperate. Every computer can run an arbitrary number of services, and each service is built in a way that ensures that the service can exchange information with any other service in the network without human interaction and without the need to make changes to the underlying program itself (Wikipedia, 2014).

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 391–397
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Microsoft (2014) defines SOA as “A loosely-coupled architecture designed to meet the business needs of the organization.” They offer the following “facts” about SOA:

- SOA is a design philosophy independent of any vendor, product, technology or industry trend. No vendor will ever offer a “complete” SOA “stack” because SOA needs vary from one organization to another. Purchasing your SOA infrastructure from a single vendor defeats the purpose of investing in SOA.
- SOAs may be realized via Web services but Web services are not necessarily required to implement SOA
- EDI, CORBA and DCOM were conceptual examples of SOA
- SOA is not a methodology
- SOAs are like snowflakes—no two are the same. A SOA Reference Architecture may not necessarily provide the best solution for your organization
- SOA should be incremental and built upon your current investments
- SOA is a means, not an end
- Focus on delivering a solution, not an SOA. SOA is a means to delivering your solution and should not be your end goal.

In essence, SOA is a program that enables the Information Technology (IT) function to design and deliver the information needed for an organization to operate effectively and efficiently.

Objectives (Reasons for Adopting Program)

One of the primary objectives of SOA is to enable an organization to improve its information technology (IT) agility—its ability to rapidly adapt its operations, processes and relationships in a rapidly changing business environment. With traditional monolithic architecture of IT applications, it is difficult, expensive and time consuming to make changes in applications (Choi, Nazareth, & Jain, 2010).

History (Time Line, Reasons Originated, Principal Developers)

Löhe and Legner (2010) suggest that SOA is an outgrowth of the Inter-organizational system (IOS) movement, which was a means of enabling different organizations to communicate through computer networks. An example of an early IOS was electronic data interchange (EDI). As a means of comparing IOS with SOA, the authors conducted a study of cases from different industries on a number of factors, grouped as:

- Strategic layer—covers the characteristics and configuration of business networks.
- Process layer—further refines the inter-organizational coordination by means of cooperation processes.
- IS/IT layer—depicts the technical architecture that supports inter-organizational integration.

At the strategic layer, they found most of the SOA projects are vertically integrated business networks (B2B), involving partners from the same industry in typical forward- and backward integration scenarios. These projects are predominantly in stable network environments and are motivated by the need for customer access or need for improvement.

At the process layer, most of the applications were in commerce, finance, and supply chain processes. Most of the outputs were virtual products or services. Error-prone processes and high-coordination efforts were the main challenges, while capacity utilization and process complexity and costs were important drivers of change to SOA.

At the IS layer, the study found that SOA is still mostly applied to build information systems within an organization's boundaries. In the majority of cases, firms use an SOA-based infrastructure offered by an external partner without having to implement a SOA themselves. Stable environments and human-to-machine were predominant factors in the cases studied.

The authors conclude that most SOA-based business networks are still stable and rely on predefined arrangements Löhe and Legner (2010).

Some see SOA as the forerunner of Service-Oriented Systems (SoS), which is defined as a "set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities" (Systems Engineering Guide, 2008). "Several service-oriented principles that have contributed to wider SOA adoption—standardization, loose coupling, strategic service identification, service discovery mechanisms, and governance—also work for SoS" (Lewis et al., 2011, p. 59).

Figure 11G.1 shows the number of articles written about SOA. The first appeared shortly after the turn of the century and grew rapidly until about 2008, and have declined significantly since, with most of the articles in trade journals. The decline is probably not the result of less interest;

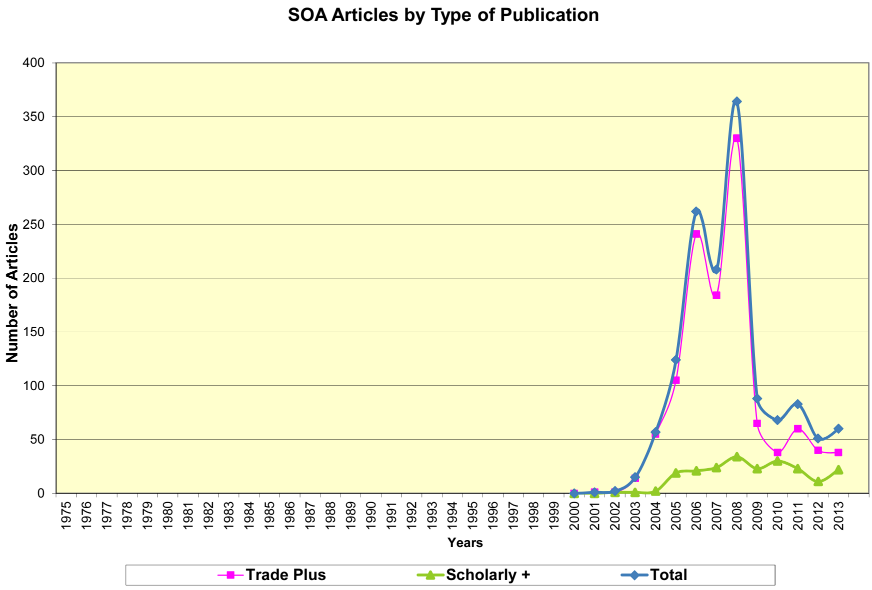

Figure 11G.1. Total number of SOA articles.

rather, it may be because of the rise of software as a service (SaaS) and cloud computing interest.

Expected Benefits (Tangible and Intangible)

Choe, Nazareth, and Jain (2010) list several benefits from SOA:

- Permits quicker and more responsive change to applications through the selection and integration of appropriate services; this is not available through legacy applications.
- Gives an organization an advantage over its competitors
- Provides an organization with benefits of higher quality and reduced maintenance through reuse.
- Serves as a vehicle to align a firm's IT strategy with its business strategy.

Other benefits proposed by Mircea and Andreescu (2012) include:

- Agility to collaborate (ability to securely and easily share information with partners and stakeholders)

- Agility to adapt to market (promotes the ability to rapidly reconfigure the business process
- Reduction of cost
- Improvement in efficiency (promotes a modular enterprise, promising a high degree of reusability of business services, ensuring consistency
- Better business operations
- Ease of introducing new technologies

Barriers to Acceptance

Implementation of SOA involves the alignment of technology, infrastructure and culture. The technology is varied and not completely standardized, and requires careful matching of system to need. The infrastructure in most organizations must be changed, sometimes radically, to adapt internally and also to adapt to other participants in the external network. Perhaps most difficult of all, the culture among employees must be adapted to a new way of operating.

SOA requires taking an idea and forming it into a tangible program with specifics about tasks, technologies, resource requirements, target completion dates, and expected results. The program must be designed for users who may or may not understand the details of the technologies used. Conversely, the technologists may not comprehend the needs of the users. It is almost inevitable there will be conflicts to be recognized and resolved.

Implementation Approach

SOA applications can lead to a service-oriented enterprise (SOE), which "involves the application of service orientation in all main operations and management of the enterprise, including human resources, business processes, information systems and decisions management." Mircea and Andreescu (2012, p. 2) They outline the following levels of SOA maturity in an organization:

- Level 1—Initiation. There is minimal interest in SOA and not infrastructure; training is needed.
- Level 2—Experimenting. The organization is exposed to information and business capabilities as a service within and outside the department.

- Level 3—Integration. The program is expanded to provide information and business capabilities as a service within and outside of several departments.
- Level 4—Standardization. The enterprise-wide SOA infrastructure is developed. SOA is use to facilitate the cooperation and improvement of business processes, but is not integrated.
- Level 5—Self-managed. SOA is integrated at the organization level and organizations may respond proactively to market changes.
- Level 6—Adaptive. SOA is fundamental for all important operations, both internal and with business partners, and for management of the business.

A recent study, using case studies and interviews, looked at the critical success factors (CSF) in implementing SOA. Out of 20 CSF used, the study found that "Clear goal-setting based on business value," and "Step-by-step evolution planning with consideration of current capacity," were important to both vendors and users (Lee, Shim & Kim, 2010).

Future

Organizations are trying to become more agile to better respond to changes in rapidly globalizing competition by adopting service orientation—commoditization of business processes, architectures, software, infrastructures and platforms. "Today, SOA, cloud computing, Web 2.0 and Web 3.0 are converging, and transforming the information technology ecosystem for the better while imposing new complexities" (Delen & Demirkan, 2013, p. 359). To do this, companies must confront the rise of big data, with its complexities of lack of structure and disparate networks in virtual communities. This requires an extension of data-as-a-service and information-as-a-service into analytics-as-a-service. Analytics-as-a-service, or business analytics, includes:

- Descriptive analytics—well defined business problems and opportunities through business reporting, dashboards, scorecards and data warehousing
- Predictive analytics—accurate projections of the future states and conditions, through data mining, text mining, web/media mining and forecasting
- Prescriptive analytics—best possible business decisions and transactions, through optimization, simulation, decision modeling and expert systems.

Business, or predictive, analytics is growing rapidly. SOA and the cloud infrastructure offer the capabilities and flexibility needed to make these concepts work (Delen & Demirkan, 2013).

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CHAPTER 11H

SOFTWARE AS A SERVICE (SAAS) AND CLOUD COMPUTING

NAME AND BRIEF DEFINITION

Cloud computing is a term that is one of the new most popular of new management programs. It has varied meanings and interpretations and is sometimes indistinguishable from Software as a Service (SaaS) Service-Oriented Architecture (SOA) and Application Service Provider (ASP). We will use the general term cloud computing in describing this group of programs.

Software as a service. Computer services are provided by a third party that keeps all of the software and hardware in its place of business and the company using the services accesses them via the internet. A very common technique used to outsource technological state-of-the-art costs that can be avoided (Blackstone, 2013).

Cloud computing. An emerging way of computing where data is stored in massive data centers which can be accessed from any connected computers over the internet (Blackstone, 2013).

Service-oriented architecture (SOA). An IT architecture that makes it possible to construct business applications using Web services, which can be reused across an organization in other applications (Magal & Word, 2009).

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 399–405
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Software-as-a-Service (SasS). A method of delivering software in which a vendor hosts the applications and provides them as a service to customers over a network, typically the Internet. Customers do not own the software; rather, they pay for using it. SaaS makes it unnecessary for customers to install and run the applications on their own computers (Magal & Word, 2009).

Cloud computing. A type of computing where tasks are performed by computers physically removed from the user and accessed over a network (Magal & Word, 2009).

Service-Oriented Architecture (SOA). In the early 2000s, companies began to Web-enable their three-tier applications so that users could access the systems through a Web browser. During these years companies also benefited from new technologies that could help link, or integrate, many different client-server systems together in new and very valuable ways. These new technologies are collectively labeled service-oriented architecture, or SOA. By using Web services, companies could now integrate several client-server applications and create an enterprise mashup, or composite applications. Composite applications and mashups rely on Web services to send and receive data between and among ES. In addition, they execute newer and more specific processes than are found in the standard ES (enterprise system) (Wikipedia, 2011).

Application service provider (ASP). A business that provides computer-based services to customers over a network. Software offered using an ASP model is also sometimes called On-demand software of software as a service (SaaS). The most limited sense of this business is that of providing access to a particular application program (such as customer relationship management) using a standard protocol such as HTTP (Wikipedia, 2011).

Wikipedia (2011) further expands on cloud computing in the following description.

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid.

Gartner (2011) defines cloud computing as a style of computing where massively scalable IT-enabled capabilities are delivered as a service to external customers using Internet technologies. They extend this definition into four supportive concepts:

- Implementation includes definition and measurement of the service to enable payment based on usage, not on physical assets.
- Scalability is required because economies of scale should reduce the cost of the service; implicit are flexibility and low barrier of entry.

Table 11H.1. NIST Definition of Cloud Computing

After years in the works and 15 drafts, the National Institute of Standards and Technology's (NIST) working definition of cloud computing, the 16th and final definition has been published as *The NIST Definition of Cloud Computing* (NIST Special Publication 800-145).

Cloud computing is a relatively new business model in the computing world. According to the official NIST definition, "cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."

The NIST definition lists five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services. The definition is intended to serve as a means for broad comparisons of cloud services and deployment strategies, and to provide a baseline for discussion from what is cloud computing to how to best use cloud computing.

"When agencies or companies use this definition," says NIST computer scientist Peter Mell, "they have a tool to determine the extent to which the information technology implementations they are considering meet the cloud characteristics and models. This is important because by adopting an authentic cloud, they are more likely to reap the promised benefits of cloud—cost savings, energy savings, rapid deployment and customer empowerment. And matching an implementation to the cloud definition can assist in evaluating the security properties of the cloud."

While just finalized, NIST's working definition of cloud computing has long been the de facto definition. In fact before it was officially published, the draft was the U.S. contribution to the InterNational Committee for Information Technology Standards (INCITS) as that group worked to develop a standard international cloud computing definition.
The first draft of the cloud computing definition was created in November 2009. "We went through many versions while vetting it with government and industry before we had a stable one." That one, version 15, was posted to the NIST cloud computing website in July 2009. In January 2011 that version was published for public comment as public draft SP 800-145.

Researchers received a large amount of feedback, which mainly dealt with interpretations. The definition from draft to final remained substantively the same and only a modest number of changes were made to ensure consistent interpretations. *The NIST Definition of Cloud Computing* (SP 800-145) is available at http://csrc.nist.gov/publications/PubsSPs.html#800-145.

- Internet delivery implies specific standards are pervasive, accessible and visible in a global setting.
- Services are provided to multiple external customers; this extended coverage will increase the economies of scale.

A more detailed definition of Cloud Computing is shown in Table 11H.1 from the National Institute of Standards and Technology (NIST).

Objectives (Reasons for Adopting Program)

The primary objectives for a user of outsourced computing are to (1) reduce investment and operating costs; and (2) obtain access to advanced computing technologies. These are major benefits to smaller companies who may not have the capital to invest in needed resources to remain competitive or to satisfy larger customers. If they do not have the internal staff to manage an in-house IT capability, accessing applications through third party providers becomes attractive.

History (Time Line, Reasons Originated, Principal Developers)

Cloud computing, as well as SaaS and SOA, had their origins almost a century ago. The idea of selling information processing services began in the 1930s when IBM introduced their service bureaus to take data from clients and use their data processing equipment to organize that date into meaningful results.

The following describes the evolution from service bureaus to cloud computing:

- 1930s-1940s—Service bureaus (before computers), IBM. Customer takes data to the service bureau for processing. One of the early businesses was Automatic Payrolls Inc., later Automatic Data Processing (ADP) for payroll.
- 1950s–1970s—mainframe computers, primarily for larger companies, who owned hardware and built their own software.
- 1960s–1970s—Time sharing. Customers could access a mainframe directly.
- 1980s—PCs came and killed time sharing because even small companies could afford PCs.
- 1990s—Beginning of application service providers (ASP) and its follow-on programs—Service-oriented architecture (SOA), Software as a Service (SaaS), and cloud computing (Campbell-Kelly, 2009).

Figure 11H.1 shows the number of articles reported for SaaS. Beginning about 2005, the number rose rapidly through 2008 and has been declining since, probably as more articles are being written with "cloud computing" as the key focus. Most of the articles have been in trade journals and the initial interest has slowed without a corresponding increase in scholarly journal articles.

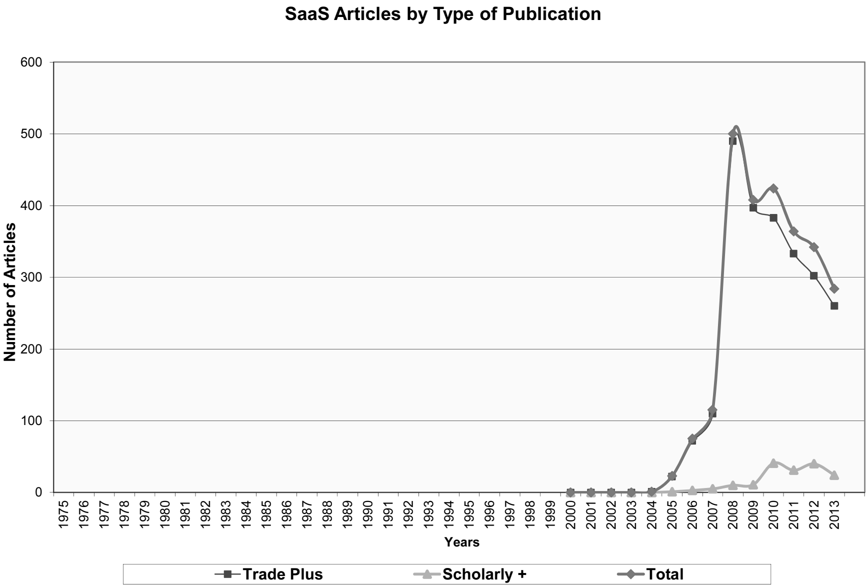

Figure 11H.1. Total number of SaaS articles.

Expected Benefits (Tangible and Intangible)

The major benefits expected are reduced operating costs and reduced investment in hardware, software and staff. Additional benefits include:

- Total cost of ownership is known. Compared to the uncertainty of in-house IT projects, the cost of cloud computing can be fixed in advance.
- Access to leading edge technology and software. Providers will have to continue to improve their offerings to remain competitive.
- Faster startup in new applications. In theory, a user can quickly access a new application and begin using it. While new applications don't always run smoothly, problems should be quickly resolved.
- Higher level of system integrity. Providers can't afford to have intermittent service or lax security. Users can as quickly leave as they sign on.
- Scalability of applications. Users can increase or decrease their use of the cloud as needed, without concern for insufficient or excess capacity.

- Risk mitigation. The uncertainty of software upgrades, post-release operating failures, and other operating failures are avoided (Waters, 2005).

Barriers to Acceptance

A group from the UC Berkeley Reliable Adaptive Distributed Systems Laboratory (RAD Lab) offered the obstacles to cloud computing.

- Uncertainty about business continuity and service availability from cloud providers.
- Data lock-in. Difficulty in extracting data from one site to another
- Data confidentiality and auditability (questionable security)
- Data transfer bottlenecks. High cost of shipping data and capacity availability
- Performance unpredictability
- Availability of scalable storage
- Bugs in large-scale distributed systems
- Ability to scale quickly either up or down
- Legal issues
- Software licensing fee fluctuations (Ambrust, Fox, Griffith, Joseph et al. 2010)

Another concern for companies would be the limited applications currently available in the cloud. While the scope of applications is increasing rapidly, they are not all available from one provider, which raises the potential for lack of capability between users and providers.

Implementation Approach

In theory, the implementation to cloud computing, or its variants, can be almost immediate. In practice, it may take longer, not because of the inadequacy of the systems services offered but because of the inadequacy of the user company's information and procedures. Consequently, the approach to implementation could consist of the following steps:

- Decide to use cloud computing because it is the correct strategic move.
- Identify the applications to be assigned to the cloud.

- Select the provider that best fits with the user's needs.
- Determine the information and procedures needed to fit with the service provider.
- Make the internal changes as needed.
- Initiate the connection to the cloud applications.
- Evaluate and adapt as necessary.

Future

In an age of rapidly changing technologies, the future of any current popular program is uncertain. From a linear point of view, cloud computing should continue to gain popularity as successful implementations become commonplace. However, new disruptive forces may slow its growth or even lead to its demise.

Today's slowed economic conditions make reduced investments an attractive alternative for many organizations, especially small ones. As economic conditions move to a more favorable situation, some organizations who now favor cloud computing may move to establish in-house capabilities with the benefits of lower costs, higher security and enhanced ability to innovate.

In addition, some new, as yet unknown, technology may displace cloud computing as the favored approach. After all, who envisioned cloud computing even ten years ago?

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CHAPTER 12A

NEW PRODUCT DEVELOPMENT (NPD)

NAME AND BRIEF DEFINITION

The APICS Dictionary defines a product as “any good or service produced for sale, barter, or internal use” (Blackstone, 2013). In recent years, the definition of product expanded to include the combination of goods and services. Very few goods are sold today without being combined with a variety of services. Some writers suggest that the combination of goods and services should be expanded to provide an “experience” for the consumer (Pine & Gilmore, 1999). A visit to Disney World, or a train ride through the Rockies, is more than food and rides; it is an unforgettable experience. Because of this expanded view of products, the job of developing new products is becoming more complex and requires a combination of talents and resources to accomplish successfully.

In addition, product life cycles are decreasing. At one time, companies could expect a successful product to last several years, with only minor tweaks being required to keep it fresh in the minds of users. Today, many product life cycles of months, or even weeks, are becoming the new normal. Rising expectations of customers and global competition is placing new demands on companies to bring new products to market faster and continuously.

Combined with shortened product life cycles, it becomes clear that new product development (NPD) is not a task that can be treated as an “as needed” effort, but must become a continuous management function if a

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company is to be successful. In the past, companies could funnel 100 new ideas into their product development process and be elated if one or two new products emerged, after months or years of being bounced around in the process. This approach is not good enough today and will certainly be inadequate in the future. Companies have to find ways, to not only shorten the time from concept to market, but also reduce the risk of unsuccessful efforts.

Objectives (Reasons for Adopting Program)

What is driving the need for more new products? There are at least three: global competition, increasing consumer affluence, and environmental concerns.

Both trade and academic publications stress the impact of increased global competition. As a result, products have to meet several requirements, including competitive costs, high and sustained quality, fast response times and flexibility in design and operation. It is no longer good enough to have just low prices; it is necessary to meet all of the new product requirements, although the emphasis may change from market to market.

Consumers are becoming more affluent, in all parts of the world. Even in emerging countries, there is a growing market for products of all types and configurations. Whether the result of different cultures, income levels, or other uniqueness, consumers desire different products.

There is increasing awareness of the need to be more mindful of the effect of products on the environment. This requires several new considerations in designing products:

- Eliminate hazardous materials (computers)
- Make products and their components recyclable at their end-of-life (appliances)
- Reduce the carbon emissions during product use (automobiles)

See Crandall (2006 and 2009a) for additional information and references.

NPD Orientation

As a result of the above drivers, companies are feeling the pressure to develop new and better products—faster. One approach is to increase the success rate of their NPD efforts by being sure the product being developed is what the customer wants and will buy.

In his book Adaptive Enterprise, Stephan Haeckel (1999) encourages companies to move from a "make and sell" orientation to one of "sense

Table 12A.1. Make-and-Sell Versus Sense-and-Respond

Make-and-Sell	*Sense-and-Respond*
• Assumption: Predictable, continuous, linear change	• Assumption: Unpredictable, discontinuous, non-linear change
• Goal: Become an efficient enterprise	• Goal: Become an adaptive enterprise
• Approach: Operate as a closed system without considering external signals	• Approach: Operate as an open system considering external signals

and respond." Table 12A.1 shows his distinction between the two approaches.

Haeckel points out there are fundamental differences between the Industrial Age economy and the Information Age economy; therefore, a fundamentally different kind of business organization is required. As shown in Table 12A.1, the future will require companies to manage in an unpredictable environment. The NPD process must consider not only what the customer needs but also the changing environment in which the products will be used.

A similar approach presented by Conley (2008) outlines moving from product-centric to context-centric. He describes the scope of product-centric as including product functions, features, benefits, price, value proposition and variations. In contrast, context-centric includes the business environment, relationships, other products, interactions, processes, activities, and the people involved. He believes the contextual orientation broadens a company's view while maintaining a connection to what matters to its customers.

Another useful distinction is between product attributes and benefits. Attributes are features, functionality, and performance, or the things that are designed into the product. Benefits are what customers or users value and are willing to pay for—ease of use, durability and the like. Often, benefits and attributes are aligned; however, sometimes the designers get it wrong, so that the added product features and performance do not yield additional benefits for customers or users (Cooper, 2005).

Each of the above approaches highlights the need for companies to become more aware of "the voice of the customer" (Crandall, 2010). The costs and risks of failure are too high for companies to ignore; they must address the potential of better NPD methods (Crandall, 2009b). Determining what the customer wants or needs is difficult, because customers often are not able to express their needs or wants in a meaningful way. Quantitative methods of information gathering are used extensively, such as preference surveys, attribute experiments, and in-market-based research. The quantitative methods are supplemented with qualitative methods such as industry analogies, focus groups, and ethnography (careful monitoring and observations of actual product/service users in live-use settings) (Boike, Bonifant, & Siesfeld, 2005).

In explaining the difficulty of discovering what the customer needs, Oliver Julien, former product design specialist at Ford Motor Company and co-owner of Design Concepts, an award-winning product design company, describes the process of directly observing how users "cope" with the limitations of the product they are presently using. How do bill payers organize, or reorganize, their workplace to enable them to write checks and file documents? How do individuals with both hands full open a door that only opens toward the person? Once problems can be detected and corrected, the benefits are obvious—back-up sensors on cars to avoid obstacles that cannot be seen in the rear-view mirrors (Julien, 2010).

Strategies

What are the basic kinds of new products? Table 12A.2 shows one classification and a comparison between best performing companies and worst performing companies.

As shown in Table 12A.2, the best performers spend more of their resources in developing major product revisions and new products (65%) as contrasted with the worst performers, who devote only 47% in major revisions and new products.

Christensen (2003) has also written extensively about the need for companies to avoid the trap of only making incremental improvements in existing products, and reserve some of their resources to develop disruptive products, which can displace existing products, even those that are leaders. Pine (1993) and others have written about the need to move toward mass customization of products. Often, existing product designs make it impossible, or impractical, to modify production processes enough to achieve customization. Consequently, it is important that new

Table 12A.2. Types of New Product Development (Percentage of NPD Projects)

Type of Product	*Best Performers*	*Worst Performers*
Promotional developments and package changes	6%	13%
Incremental product improvement and changes	29%	40%
Major product revisions	25%	19%
New to the business products	24%	20%
New to the world products	16%	8%
Total NPD Projects	100%	100%

products be designed with the flexibility to be customized for different customer requirements.

New Product Portfolio

In order for new product planning to be successful, it should be an ongoing process, both at the strategic and tactical levels. One way of providing continuity in NPD is by developing a new product portfolio. There are two objectives of portfolio planning.

The primary objective of portfolio planning is to transform the business strategy of a company into effective and specific new product investments. These investments should be directed at products that will create growth in revenues and profits, and increase the company's competitive strength, both now and in the future.

A secondary objective is to provide strategic guidance to the firm's various capability development activities, such as:

- Hiring new employees,
- Training and developing the entire workforce,
- Gaining new tools for product design and development,
- Developing new business processes,
- Adding new manufacturing abilities, and
- Developing new strategic partnerships.

Achieving this second objective ensures the firm will steadily improve its capability to develop the needed new products. New product portfolios require continuous review and careful resource management (Patterson, 2005).

History (Time Line, Reasons Originated, Principal Developers)

Figure 12A.1 shows the number of articles written about NPD. Although there were some articles during the 1980s, the subject became more popular during the 1990s, and has continued to increase during the past decade. Although there has been some increase in the number of trade articles, they are far outnumbered by scholarly journal publications.

A recent study shows strong growth in the number of articles on NPD in each category of journal selected. The study found a continuing evolution in research topics and increased sophistication in quantitative techniques over the 16-year period. Overall this review of the NPD literature

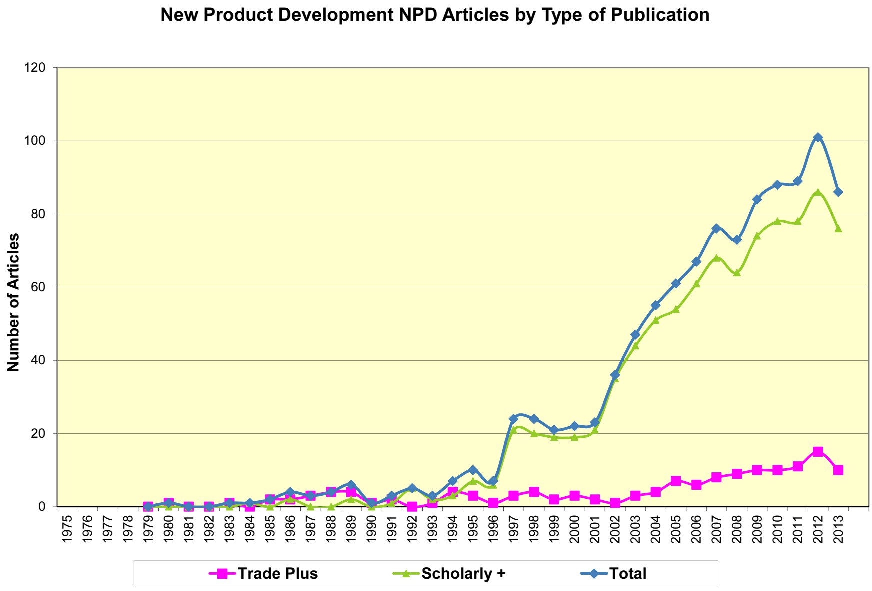

Figure 12A.1. Number of NPD articles.

uncovers encouraging signs of a maturing discipline (Page & Schirr, 2008).

Expected Benefits (Tangible and Intangible)

It is not possible to define a single set of new product development (NPD) activities or steps that fit all firms. However, it is possible to develop a framework that successful companies within an industry are likely to focus on to achieve the best possible results within the constraints of their market. Compared to their competitors, top performers consistently put more strategic emphasis on each of the following activities: customization, new product introduction, design innovation, product development cycle time, product technological innovation, product improvement, new product development, and original product development (Calantone, Vickery, & Droge, 1995).

The current state of business in the United States and the world is one of rapid change. *Product* life-cycles are becoming shorter, requiring firms to reduce the time to bring *new products* to market. Being early can provide a significant competitive advantage, thereby making the *new product development* (*NPD*) an important area for research. Some approaches that focus on the reduction of time required to complete the overall NPD cycle are: (1) Simplify; (2) Eliminate delays; (3) Eliminate steps; (4) Speed up operations; (5) Use parallel processing. The acceleration approaches should focus on the development of quality products. Any added costs presented by the introduction of these approaches will be more than compensated for by the time and cost reductions achieved in the modification of the NPD process (Millson & Wilemon, 1992).

Effective integration of suppliers into NPD can yield such benefits as reduced cost and improved quality of purchased materials, reduced product development time, and improved access to and application of technology (Ragatz, Handfield, & Scannell, 1997).

Early supplier involvement can provide the following benefits:

- Shorter project development lead times
- Improved perceived product quality
- Savings in project costs
- Better manufacturability
- Shared knowledge and learning
- Improved NPD efficiency and effectiveness
- Accessibility to supplier's technical capability (Mikkola & Skjoett-Larsen, 2003).

Improving alignment between supply chain and NPD can enhance market impact and revenue growth. Additionally, it can remove a lot of frustration for supply chain managers, who currently are often the last to find out about NPD, whereas their contribution is crucial when it comes to getting products to market on time and in the right volumes (van Hoek & Chapman, 2007).

Barriers to Acceptance

Team learning is vital for organizations developing new products under rapidly changing technological and market conditions. Recent NPD literature demonstrates the essential role of improvisation (i.e., planning and executing any action simultaneously) and unlearning (i.e., changes in team beliefs and project routines) for effective learning and performing under turbulent conditions (Akgun et al., 2007).

In today's network world, advancement in NPD may involve different types of networks, joint ventures, alliances, outsourcing and mergers. Managing the integration of an NPD process in this increased organizational complexity requires a sophisticated organization design to facilitate and support the coordination of activities and the flow of information across the networks (Badir, Buchel, & Tucci, 2005).

NPD areas still in need of improved management include idea management, project leadership and training, cross-functional training and team communication support, and innovation support and leadership by management. To differentiate the "best from the rest," the best firms emphasize and integrate their innovation strategy across all the levels of the firm, better support their people and team communications, conduct extensive experimentation, and use numerous kinds of new methods and techniques to support NPD. Even the best companies appear to continue to struggle with recording ideas and making them readily available to others in the organization. What remains unclear is whether there is a preferable approach for organizing the NPD endeavor, as no one organizational approach is common to top NPD performers (Barczak, Griffin, & Kahn, 2009).

More firms face the need to access a critical resource for NPD—people who are dispersed around the world. Like other types of product development teams, global teams experience the challenge of getting a group of individuals from different functional areas to work together effectively for a finite period of time to accomplish specific project objectives. In light of the critical role that global teams play in NPD, it is surprising that understanding how to manage them effectively has not kept pace with their increasing use. There are four principal reasons for using global teams: (1) to address global markets by identifying common product platforms; (2) to identify unique needs of local markets; (3) to capitalize on globally distributed Centers of Excellence; and (4) to bring together dispersed resources (Barczak & McDonough III, 2003).

Developing cost targets during *NPD* lead to lower-cost new products, while not impairing design quality or development time. However, under high time pressure, cost targets lead design engineers to work longer on the design, without a corresponding cost decrease (Everaert & Bruggeman, 2002).

Business processes have become more simultaneous and collaborative in the recent past. In simultaneous processes, multiple parties must adapt to one another in real time as decisions evolve. For example, NPD requires collaboration in the context of Concurrent Engineering and Supply Chain Management (SCM). In both cases, parties must modify decisions based on preliminary information, information that is not fully precise or stable, about what the other parties are doing (Loch & Terwiesch, 2005).

As products become more complex, the increased complexity becomes a barrier to successful product development (Kim & Wilemon, 2003) Rapid technological development, shorter product life cycle, clockspeed competition, and increased outsourcing have prompted many firms to involve their suppliers early in their new product development activities. While there are advantages, there are also disadvantages, such as the risk of losing proprietary knowledge, hollowing out internal competencies, eased accessibility for competitors to copy or acquire key technologies, increased dependence on strategic suppliers, and increased standardization of components (Mikkola & Skjoett-Larsen, 2003).

Implementation Approach

A number of methodologies facilitate more effective new product development.

- Participative design/engineering—A concept that refers to the simultaneous participation of all the functional areas of the firm in the product design activity. Suppliers and customers are often included. The intent is to enhance the design with the inputs of all the key stakeholders. Such a process should ensure that the final design meets all the needs of the stakeholders and should ensure a product that can be quickly brought to the marketplace while maximizing quality and minimizing costs. Syn: co-design, concurrent design, concurrent engineering, new product development team, parallel engineering, simultaneous design/engineering (Blackstone, 2013)
- Quality function deployment (QFD)—A methodology designed to ensure that all the major requirements of the customer are identified and subsequently met or exceeded through the resulting product design process and the design and operation of the supporting production management system. QFD can be viewed as a set of communication and translation tools. QFD tries to eliminate the gap between what the customer wants in a new product and what the product is capable of delivering. QFD often leads to a clear identification of the major requirements of the customers. These expectations are referred to as the voice of the customer (VOC) (Blackstone, 2013). See also Crandall (2010).
- Design for manufacture and assembly (DFMA)—A product development approach that involves the manufacturing function in the initial stages of product design to ensure ease of manufacturing and assembly (Blackstone, 2013)
- Product Lifecycle Management (PLM)—Sussman (2002) defined product lifecycle management as "the marketplace name for the

comprehensive framework of technology and services that permits extended product teams—inside and outside of an enterprise—to collaboratively conceptualize, design, build, and manage products throughout their entire lifecycles." This definition pointed out two primary objectives of PLM—a technology to manage information and a concept to promote collaboration among departments within a single company or between separate companies.

- Distributed New Product Development (DNPD)—The separation and optimization of activities performed during a single product development process (i.e., product ideation, development, launch), across multiple geographic locations. These locations may be within a single corporate entity, be within subsidiaries, or involve the use of third parties (Heck & Grewal, 2005).
- Stage-gate process—A systematic new product framework with the following major stages in the new product development process: Discovery, Scoping, Build business case, Development, Testing and validation, Launch, and Postlaunch review. Each stage consists of a set of concurrent, cross-functional and prescribed activities, undertaken by cross-functional teams. A set of deliverables is the result of each stage, which must be evaluated and approved before the project moves to the next stage (Cooper, 2005).

Future

The NPD process imposes new requirements on a company. Cross-functional teams are a given. Marketing is an essential player in NPD and they have homework to do if they are to be a contributor to the NPD process. They must capture the essential needs and wants of customers and other stakeholders, and then meet with engineering and operations people to translate those needs into appropriate, and profitable, products.

Supply chain collaboration along the supply chain is necessary, both downstream with customers and upstream with suppliers. A superefficient supply chain is meaningless if the right products are not available.

Companies must truly be concerned about the voice of the customer. Recent examples of questionable corporate practices in real estate and financial institutions strongly suggest that these companies were more interested in "make and sell" than "sense and respond."

The effects of outsourcing, especially offshore outsourcing, will have a profound effect on NPD. The DNPD approach described above is one approach to dealing with widely dispersed participants in the NPD process.

Knowledge management is another vital part of NPD, not only within the company but also with its partners. Knowledge developed at the new product design stage must somehow be preserved for use throughout the product's life cycle, including the reverse logistics phase.

Finally, the NPD process involves a great deal of project management, whether with individual products or the management of the product portfolio. If a company cannot manage projects, it has little chance of having an effective NPD program.

McCarthy et al. (2006) studied the relationship of NPD and some of the concepts in complexity theory. Early research on new product development (NPD) produced descriptive frameworks and models that view the process as a linear system with sequential and discrete stages. More recently, recursive and chaotic frameworks of NPD have been developed, both of which acknowledge that NPD progresses through a series of stages, but with overlaps, feedback loops, and resulting behaviors that resist reductionism and linear analysis. It is possible to extend the linear, recursive, and chaotic frameworks by viewing NPD as a complex adaptive system (CAS) governed by three levels of decision making—in-stage, review, and strategic—and the accompanying decision rules. Their study used comparative case studies, which showed that NPD process adaptability occurs and is dependent on the number and variety of agents, their corresponding connections and interactions, and the ordering or disordering effect of the decision levels and rules. Thus, the CAS framework developed shows a fit among descriptive stance, system behavior, and innovation type, as it considers individual NPD processes to be capable of switching or toggling between different behaviors—linear to chaotic—to produce corresponding innovation outputs that range from incremental to radical in accord with market expectations.

ACKNOWLEDGMENT

Portions of this section have been adapted from Crandall, R. E. (2010). House Plans, Quality function deployment helps design a better product. *APICS Magazine, 20*(4), 28–31.

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CHAPTER 12B

SALES AND OPERATIONS PLANNING (S&OP)

NAME AND BRIEF DEFINITION

Sales and Operations Planning (S&OP)—A process to develop tactical plans that provide management the ability to strategically direct its businesses to achieve competitive advantage on a continuous basis by integrating customer-focused marketing plans for new and existing products with the management of the supply chain. The process brings together all the plans for the business (sales, marketing, development, manufacturing, sourcing, and financial) into one integrated set of plans. It is performed at least once a month and is reviewed by management at an aggregate (product family) level. The process must reconcile all supply, demand, and new-product plans at both the detail and aggregate levels and tie to the business plan. It is the definitive statement of the company's plans for the near to intermediate term, covering a horizon sufficient to plan for resources and to support the annual business planning process. Executed properly, the sales and operation planning process links the strategic plans for the business with its execution and reviews performance measurements of continuous improvement. See: aggregate planning, production plan, production planning, sales plan, tactical planning (Blackstone, 2013).

Objectives (Reasons for Adopting Program)

The primary objective of Sales and Operations Planning (S&OP) is to link forecasting, inventory planning, and manufacturing scheduling and

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sourcing. The resultant practice is critical to improving the supply-chain performance (Copacino, 1998).

"The S&OP process is the mechanism by which a company matches its supply and demand plans to insure that everyone's plans are based on achieving the same set of goals and objectives" (Lapide, 2002). Marketing must sell what production makes; production must make what marketing sells.

History (Time Line, Reasons Originated, Principal Developers)

Sales and Operations Planning originated in the 1980s. It was an extension of MRP II which used sales forecasts to develop production plans. As it became necessary to become more competitive in meeting customer demand, it was a logical step to combine the sales planning and forecasting with production planning. According to Walter Goddard, a pioneer in the development of SOP, the 1980s brought two major improvements to MRP II. The first was the expansion of production planning into sales and operations planning. This change occurred when sales and marketing took responsibility for supplying demand information, a critical element for aligning resources to economically achieve competitive levels of service. The second was the introduction of JIT and other continuous improvement programs. JIT helped companies make improvements which could then be controlled with MRP II (Goddard, 1994).

Figure 12B.1 shows the number of articles published about sales and operations planning (S&OP). Most of the articles are in trade journals, with an increasing number in scholarly publications as researchers begin to explore this rediscovered program. Richard Ling was an active speaker about S&OP in regional and national conferences as early as the 1980s, but his presentations were confined to conference proceedings and not included in popular search engines such as ProQuest (Ling & Goddard 1998).

Use of the S&OP process has continued to increase over the years. An informal survey of participants in forecasting workshops suggests that approximately 80% of the participants now have an S&OP process in their companies (Lapide, 2004a).

Expected Benefits (Tangible and Intangible)

First, S&OP serves as an integrating mechanism by which sales, marketing, logistics, and operations can synchronize their activities. Second, it creates significant economic value by reducing uncertainty and generating lower inventories, smoother production operations, and higher levels

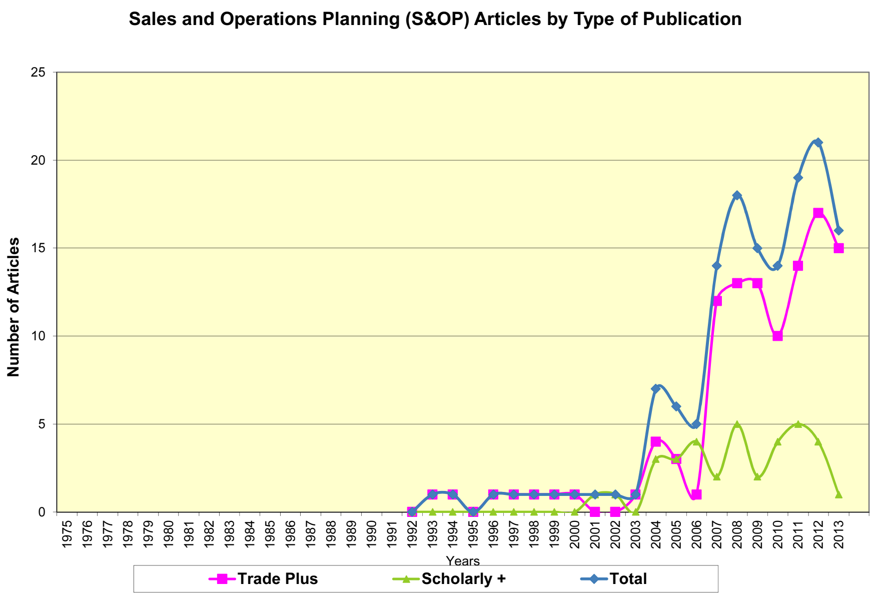

Figure 12B.1. Total number of S&OP articles.

of customer service, particularly improved product availability (Copacino, 1998).

S&OP may also be associated with the concept of supply and demand planning, which one leading advocate considers a key to effective supply chain management. He includes sales and operations planning meetings (SOPM) as an essential business practice to balancing supply and demand. He envisions meetings "where sales, forecasts, pricing and promotional plans, supply constraints and plans, and inventory positions are reviewed and reconciled" (Copacino, 2003).

Sales & operations planning (S&OP) is a process for building consensus among sales, marketing, financial, and operations to determine the best plan for meeting demand forecasts and achieving corporate business goals. Though the concept has been around for over 20 years, the convergence of globalization and the extension of supply chains have made it more relevant. Properly executed S&OP provides three key benefits: visibility, for a better understanding of the business and the balance between supply and demand; greater accountability, by having a consistent way to hold the cross-functional management team to a common set of objectives to execute daily; and better flexibility, in being able to assess how best to harness or respond to dynamic market conditions. S&OP is not about generating a better forecast, but a better understanding of the full operational process of meeting the business plan (Smith, 2004).

An S&OP process has several clear benefits. It provides the company with a formal mechanism to conduct the iterative process discussed above-that is, forecasting, followed by planning, followed by re-forecasting, followed by re-planning, and so on. A plan cannot be effective without the forecast, and it does not determine the forecast. If the resulting business plan does not meet declared financial goals, the process requires the team to reexamine the sales forecast and consider what else can be done in marketing or sales to increase the demand forecast and what additional efforts in production and logistics can increase capacity to the level necessary to meet the plan. S&OP is a rational means to decide what should be marketed and sold and when. Finally, it keeps everyone on the demand side informed of the needs and issues faced by the supply side, and vice versa (Mentzer & Moon, 2004).

Barriers to Acceptance

Lapide (2002) points out that, while developing and conducting an S&OP process sounds relatively straight-forward, it isn't. There are many obstacles that can get in the way. Most of these involve keeping people actively participating in the process so that they routinely come and routinely get engaged during the S&OP meeting. Often right-brained marketing and sales personnel get frustrated by left-brained number-oriented people from operations. Sometimes, people get busy and don't show for the meetings. Last, as time goes on, people may be reluctant to move from their relatively fixed position.

To handle these obstacles, whoever runs the meetings needs to make sure the meetings continue to focus on gaining consensus and are run as efficiently as possible so participants' time is not wasted. Also, all participants need to continue to believe in the importance of the S&OP process for the company as a whole. Often the only way to make sure that these obstacles don't get in the way is to have an executive sponsor with enough clout in the company to ensure that everyone stays committed to the process.

In summary, the S&OP process is not easy to keep going since it may be painful at times. It is, however, vital in ensuring that a company's supply and demand plans are synchronized to keep everyone in the company focused on achieving the same objectives.

Implementation Approach

The success of a S&OP program depends on several success factors. One list includes the following:

1. Ongoing, routine S&OP meetings
2. Structured meeting agendas
3. Pre-work to support meeting inputs
4. Cross-functional participation
5. Participants empowered to make decisions
6. An unbiased, responsible organization to run a disciplined process
7. Internal collaborative process leading to consensus and accountability
8. An unbiased baseline forecast to start the process
9. Joint supply and demand planning to ensure balance
10. Measurement of the process
11. Supported by integrated supply-demand planning technology
12. External inputs to the process (Lapide, 2004b)

The S&OP process produces an operational plan which consists of manufacturing plans, procurement plans, logistics plans, and human resource plans. They can be both short-term, a monthly production schedule, and long-term, an extended contract for raw materials purchases or a plan to expand manufacturing capacity. The S&OP process produces a second plan, a demand plan, where sales and marketing departments plan what should be marketed and sold, given the company's supply capability. Without accurate and credible estimates of future demand established by effective sales forecasting, it's impossible for organizations to manage their supply chains effectively (Mentzer & Moon, 2004).

Future

A recent comprehensive study of the literature on S&OP found that "Despite the existence of common process descriptors and definitions of S&OP, there is a lack of unifying frameworks for maturity models, measurement of S&OP, and constructs related to the firm's performance. The dominating perception of the role of S&OP is that it is predominantly a tactical planning tool, deployed once business and strategic plans are set, bridging these plans to operations. Although S&OP has mainly focused on an intra-company perspective, it has been gradually extended to the supply chain" (Thomé et al., 2012).

As integrated supply chains move from speculation to reality, the need for S&OP will become more critical. It will no longer be sufficient to do

S&OP within a company; it will be necessary to extend S&OP throughout the supply chain.

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CHAPTER 12C

SUPPLY CHAIN MANAGEMENT (SCM)

NAME AND BRIEF DEFINITION

Supply Chain Management (SCM)—The design, planning, execution, control, and monitoring of supply chain activities with the objective of creating net value, building a competitive infrastructure, leveraging world-wide logistics, synchronizing supply with demand, and measuring performance globally.

Supply chain—The global network used to deliver products and services from raw materials to end customers through an engineered flow of information, physical distribution, and cash. See: supply chain design, and supply chain planning (Blackstone, 2013).

The APICS Dictionary also carries definitions for the following supply chain related terms:

- Supply chain community
- Supply chain design
- Supply chain event management (SCEM)
- Supply chain execution
- Supply chain integration
- Supply chain inventory visibility
- Supply chain mastery

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- Supply chain network design systems
- Supply chain Operations Reference (SCOR®) model
- Supply chain planning
- Supply chain resilience
- Supply chain risk
- Supply chain visibility (Blackstone, 2013)

Lambert, Garcia-Dastugue and Croxton (2005) provided the following eight supply chain management processes which are included in the Global Supply Chain Forum (GSCF) framework:

Customer Relationship Management—provides the structure for how relationships with customers are developed and maintained.

Customer Service Management—provides the firm's face to the customer, a single source of customer information, and the key point of contact for administering the product service agreements

Demand Management—provides the structure for balancing the customers' requirements with supply chain capabilities, including reducing demand variability and increasing supply chain flexibility

Order Fulfillment—includes all activities necessary to define customer requirements, design a network, and enable the firm to meet customer requests while minimizing the total delivered costs

Manufacturing Flow Management—includes all activities necessary to obtain, implement and manage manufacturing flexibility and move products through the plants in the supply chain

Supplier Relationship Management—provides the structure for how relationships with suppliers are developed and maintained.

Product Development and Commercialization—provides the structure for developing and bringing to market new products jointly with customers and suppliers

Returns Management—includes all activities related to returns, reverse logistics, gatekeeping, and avoidance

The Supply Chain Council (2014) has developed another well-known supply chain model—the SCOR framework. Table 12C.1 shows the model as of January, 2014.

Objectives (Reasons for Adopting Program)

The basic purpose of a supply chain is to move products, and services, from a point of origin, such as a farm or a mine, through a series of connected activities, such as fabrication, assembly and distribution, to the ultimate customer, either another business or an individual consumer.

Table 12C.1. The SCOR Supply Chain Model From the Supply Chain Council

The SCOR Framework is the basis for all supply chain management. The metrics in SCOR provide a solid foundation for measuring performance and identifying priorities, the processes are the common language in your supply chain operations.

Measures of Supply Chain Performance
- Reliability—Perfect Order Fulfillment
- Responsiveness—Order Fulfillment Cycle Time
- Agility—Flexibility, Adaptability, Value-at-Risk
- Cost—Total Cost to Serve
- Assets—Cash-to-Cash Cycle Time, Return on Assets, Return on Working Capital

Functions of the Supply Chain
- Plan—Establish plans to position supply and resources to meet demand.
- Source—Order and receive materials and products.
- Make—Schedule and manufacture, repair, remanufacture or recycle materials and products.
- Deliver—Receive, schedule, pick, pack and ship orders.
- Return—Request, approve and determine disposal of products and assets.
- Enable—Manage business rules, performance, resources, assets, contracts, regulatory requirements and risk.

Source: Adapted from https://supply-chain.org/scor. Used with permission.

The more closely the supply chain participants are, the more smoothly and quickly the products will move.

The importance of supply chain management (SCM) has grown steadily, as managers recognize the strategic potential that it can offer. Far more than just "logistics," SCM encompasses every effort and interaction that goes into planning, sourcing, making, and delivering a final product. As a result, many now see the very basis of competition becoming increased between supply chains, with better management delivering in all key business aspects from fostering improved innovation—through collaborative development—to significantly reduce operational costs and improvements in service levels, time to market, and quality (Anon. Strategic Direction, 2003).

The core value proposition of SCM is to improve corporate profitability and return on capital through cost reduction (via reduced inventory, improved throughput, and better procurement) and increased revenues (via reduced time to market and improved product availability). Having access to accurate information about relevant costs is essential to achieving maximum benefit from a SCM initiative. Superior supply chain management practices lead to improved corporate performance. In particular, opportunities exist to significantly improve many financial and operational measures such as: inventory, cost of goods sold, cash-to-cash cycle time, revenue per fixed assets, asset utilization, and revenues (Hadley, 2004).

History (Time Line, Reasons Originated, Principal Developers)

One of the first articles written, using the acronym SCM, describes this new approach to managing. "The quest by leading companies to attain world-class operations status has taken on a significant new dimension. There is increasing recognition today of the service-based values of effective manufacturing and logistics operations. The fashionable term for this new focus on operations effectiveness is supply chain management (SCM). The supply chain is increasingly recognized as a significant opportunity for profit improvement. SCM has evolved as the strategic management approach to organizing, integrating, and operating business activities. In its basic form, SCM is a strategic concept that involves understanding and managing the sequence of activities that add value to the product supply pipeline. To implement world-class SCM, a company must: define its strategy; select an implementation framework; resolve how it wants to manage change; and identify new critical success factors that will measure SCM performance across all areas of the business" (Battaglia & Tyndall, 1991).

Figure 12C.1 shows the number of articles written about supply chain management (SCM). While supply chains have been around for centuries, the name and acronym have only been used in the past two decades. Using the ProQuest classifications, the curves are for two classifications—trade publications which includes magazines and newspapers, and scholarly publications, which includes special reports and dissertations. As with most management programs, most of the early articles were from trade publications. By 2000, scholarly articles began to increase and, in 2004, exceeded the number of articles from trade publications. This is a topic and program that is gaining rapidly in popularity with both practitioners and academics.

As supply chains have evolved, they move through various stages of development. One form of progression includes the following:

Traditional logistics—main objective is to improve supply chain efficiency by reducing inventory levels, whereas little emphasis is given to supply chain effectiveness.

Modern logistics—the focus shifts from mere cost reduction to include also service and quality improvement.

Integrated process redesign—studies, through quantitative models applied to a systemic vision of the supply chain, how to redesign the

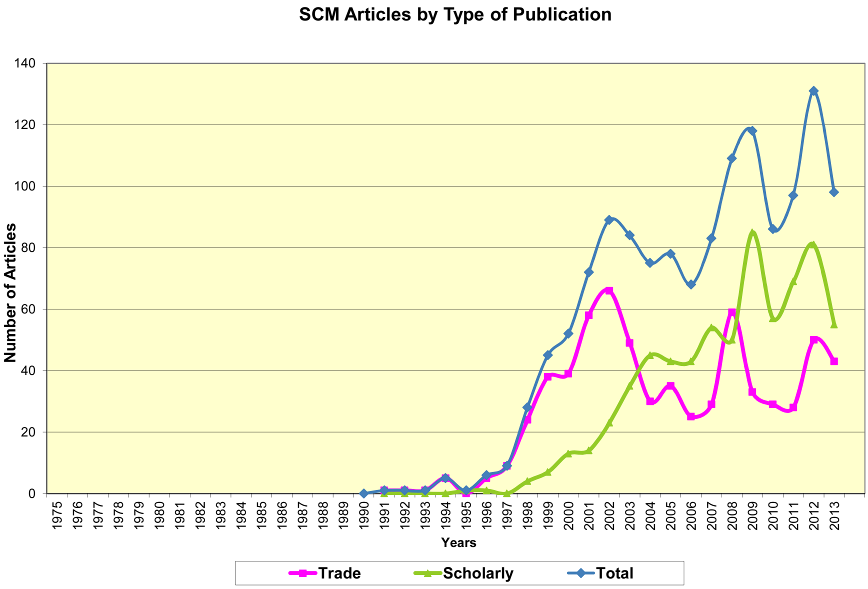

Figure 12C.1. Total number of SCM articles.

entire supply system in order to obtain more efficient and effective flows of materials and information.

Industrial organization—focuses on the strategic alliances between the various actors of the same supply chain (Cigolini, Cozzi, & Perona, 2004).

A study by Deloitte (2003) points to three critical trends that pull apart manufacturers' supply chains and make them more complex and difficult to manage:

- The unrelenting pressure to continually drive down supply chain costs, from product concept to delivery
- The pursuit of new lucrative markets and channels
- The quickening pace of product innovation

Early supply chains were identified from the viewpoint of material flow efficiency, with improvement plans focused on operations issues, such as inventory management. The supply chain was perceived as a linear progression from supplier to customer. The extended supply chain has an increasing scope of information sharing within multi-tier structure of relationships, represented as a cluster of related entities surrounding the focal company. Companies are more aware of the increasing complexity of supply chains and the need for improved inter-firm relationships (Kempainen, 2003).

Expected Benefits (Tangible and Intangible)

Supply Chain Management is a highly complex undertaking that involves multiple functional areas of an organization, including procurement (purchasing) of raw materials, production of goods and services, and distribution (logistics). It involves sales and marketing, especially in product planning and forecasting demand.

SCM can deliver powerful results—reducing costs, boosting revenues, and increasing customer satisfaction and brand equity by improving on-time delivery and product or service quality (Heckman, 2003).

Perhaps most important of all, an effective supply chain makes it possible for a company to provide good customer service by delivering the right product in a timely manner. This is especially important for consumer goods companies during the holiday seasons.

Barriers to Acceptance

One paper uncovered various underlying reasons for the need for supply chain coordination and reviews the state-of-the-art theoretical understanding of coordination problems. Organization theory, economic theory and operations management theory are all explored in order to understand the different sources of coordination problems and their potential solutions in intra- and inter-organizational contexts. The theoretical analysis concludes with six main causes of coordination problems: limited rationality, high uncertainty, decentralization, high interdependence, lack of information, and behavioral problems (Wong, 2004).

Another barrier is the inherent complexity of supply chains. The major paradoxes of complexity include:

- **The optimization paradox**. Despite the potentially huge economies from designing supply chains from a global view, most manufacturers optimize locally.
- **The customer collaboration paradox**. Despite the need to be much more responsive to customers, few manufacturers are collaborating closely with them.
- **The innovation paradox**. Product innovation is continuing to accelerate, yet few manufacturers are preparing their supply chains for faster new product introduction.

- **The flexibility paradox**. Flexibility is a key priority, but it is being sacrificed in the drive to cut unit cost.
- **The risk paradox**. Keeping supply chain quality high is critical, yet manufacturers' risk of supply chain failures keeps growing. (Deloitte 2003)

SCM has become common practice across all industries and a steady stream of articles dealing with theories and practices of SCM have been published; however, the topic of performance measurement of SCM does not receive adequate attention. As a management tool, performance measurement provides the necessary assistance for performance improvement of pursuit of supply chain excellence. However, many critical drawbacks prevent existing performance measurement systems from making significant contributions to the development and improvement of SCM (Chan, 2003).

Trust is generally considered critical to successful SCM; however, it is one of the most difficult to measure. Handfield (2004) lists eight different conceptual paradigms of trust: reliability, competence, goodwill (openness), goodwill (benevolence), vulnerability, loyalty, multiple forms of trust, combining trust with vulnerability, and non-partisan proactive-based trust. Crandall (2008) also stresses the need for trust among supply chain participants.

Implementation Approach

Supply chain management (SCM) is implemented by integrating corporate functions using business processes within and across companies. Several process-oriented frameworks for SCM have been proposed but only two of these provide sufficient detail to enable implementation—the Supply-Chain Operations Reference (SCOR) framework and The Global Supply Chain Forum (GSCF) (Lambert, Garcia-Dastugue, & Croxton, 2005).

A variety of strategic success factors have been identified, including:

- Building customer-supplier relationships
  - Establishing communication channels
  - Forming cross-functional teams
- Employing information and communication technologies
  - Web-based IT tools
  - Fact-based decision-making support
  - Online security

- Re-engineering material flows
    - Reducing inventory levels
    - Logistics network design
- Changing corporate culture
    - Management support and commitment
    - Participative management
    - Identifying supply-wide performance measures (Chin, 2004)

What is needed for successful SCM implementation?

- High level leadership
- Managing the supply chain from a central point within the organization
- Taking a broad (global) approach rather than a local optimization approach
- Representation by both the demand and supply sides of the organization
- View IT technology as an enabler, not sufficient by itself (Heckman, 2003)

Companies have spent a lot of effort in developing their forward supply chains. Soon, they will need to expend the same effort on their reverse supply chain. Reverse supply chains add complexity to closed-loop supply chain management due to new coordination issues. Examples include cross-border waste transportation, more complex trade-offs in supply chain objectives, (perceived) conflicts of interest amongst participants, micro internalization of macro externalities, and so on. Most companies do not see reverse chains as a means by which to thrive in today's marketplace. However, there is sufficient evidence that closed-loop concepts can strengthen a company's competitiveness. Pioneering firms have leaned that making returns profitable relies on good design of reverse chain business processes—including the possible integration with the forward chain. Moreover, they have learned that product design is crucial (Krikke, 2004).

The basic business processes in the reverse chain include:

- Product acquisition—retrieving the product from the market
- Reverse logistics—transportation to the location of recovery; may include testing and inspection
- Sorting and disposition—depends on product characteristics and market demand

    - Direct reuse
    - Repair
    - Refurbishment
    - Remanufacturing
    - Cannibalization
    - Scrap
- Recovery—retrieving, reconditioning, and regaining products
- Re-Distribution and sales—may use existing forward channels or develop new ones (Krikke, 2004)

There are four main types of returns:

- End-of-life returns—taken back to avoid environmental or commercial damage
- End-of-use returns—returned due to end of the lease, trade-in, or product replacement
- Commercial returns—linked to the sales process; heavy in catalog and e-commerce
- Re-usable returns—related to consumption, use, or distribution of the main product: containers, pallets (Krikke, 2004).

Building a strong supply chain is essential for business success, but when it comes to improving their supply chains, few companies take the right approach. Many work to make their chains faster or more cost-effective, assuming that those steps are the keys to competitive advantage. However, supply chains that focus on speed and costs tend to deteriorate over time. Great companies create supply chains that respond to abrupt changes in markets (agile), adapt their supply networks when markets or strategies change, and align the interests of the partners in their supply chains with their own (Lee, 2004).

Future

Supply chains, and their management, will become increasingly important as companies continue to move aggressively into global trade and sourcing. There are several issues that will merit the attention of businesses in the future, including:

- Finding the balance point in the outsourcing decision
- Incorporating appropriate sustainability programs as part of their ongoing operations
- Building effective collaboration into their integrated supply chains
- Learning and cultivating the value of trust with their supply chain partners
- Recognizing the need for and building risk management and crisis avoidance programs
- Developing knowledge management systems
- Cultivating loyal employees during disruptive change
- Learning to participate in the management of supply chains
- Integrating ethical considerations into their decision-making process

If professionals want to more clearly identify a supply chain's management structure, they need to control not only operations within their own companies, but also (and perhaps more importantly) the interfaces, or relationships, among organizations. Davis and Spekman (2004) distinguish between typical and emerging boundary-spanning activities. Typical boundary-spanning activities, such as gatekeeping (managing information flow); transacting (managing goods flow); and protecting (due diligence, forecasting, and monitoring supplier performance) are not new. Emerging boundary-spanning activities include information exchange, formation and implementation of strategic relationships, comanagement of external manufacturing, and leveraging the skills of the supply chain. The authors believe a skills gap exists in most organizations, which limits people's ability to manage essential boundary spanning activities.

Building interfaces requires technology, primarily in the form of interorganizational systems that enable supply chain partners to communicate effectively. In addition, supply chain members must be willing to share information with partners. However, lack of trust remains one of the most intractable barriers to achieving integrated supply chains (Crandall, 2008).

The sheer complexity of most supply chains makes it impossible to manage them with the same level of precision that company leaders can have in handling internal operations. As such, whatever the approach taken, supply chain members can tackle only the vital few issues that arise.

One group of researchers summarizes their efforts with the following: "Our study suggests an increased need for emphasis on managing the supply chain and the key role that knowledge-sharing plays in effective supply chains. More broadly, collaborative interorganizational relationships, such as supply chains, can be strategic weapons geared toward improving focal firm performance" (Crook, et al., 2008).

The future will be challenging, both emotionally and intellectually. Organizations will have to continue to create and refine their supply chains in order to remain competitive.

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CHAPTER 12D

CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

NAME AND BRIEF DEFINITION

Customer Relationship Management (CRM)—A marketing philosophy based on putting the customer first. The collection and analysis of information designed for sales and marketing decision support (as contrasted to enterprise resources planning information) to understand and support existing and potential customer needs. It includes account management, catalog and order entry, payment processing, credits and adjustments, and other functions. Syn: customer relations management (Blackstone, 2013).

What should the CRM program do? Doyle (2005) provides a detailed checklist of activities in CRM. Ling and Yen (2001) develop an analysis framework and implementation strategies for CRM. They also describe the evolution from the direct sales of a bygone era to mass marketing in the 1960s to target marketing in the mid-1980s to CRM in the 1990s. Payne and Frow (2005) provide a conceptual framework for CRM strategy consisting of the strategy development process, value creation process, multichannel integration process, information management process, and the performance assessment process. CRM programs have the following major components:

- CRM collects information about customers, primarily from sales transactions, but also from a number of other "touch points," such as complaints or inquiries. E-CRM is popular as a means of record-

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ing website contacts, searches and other non-sales activities. For example, Amazon.com recommends books based on your previous searches and requests that you provide reviews of books that you have purchased.

- From the collected data, a CRM program organizes the customer base into segments, or groups, of similar customers. The groups may be organized around age, income level, location, books searched, or whatever the marketing group deems useful. The ultimate objective is to get to a group of one (an individual customer), if that is practical.
- The marketing organization designs a program to appeal to the groups described above. While the primary emphasis of a CRM program is customer retention, marketers are not above designing sales programs that will attract new customers. As an example, Winer (2001) describes some typical programs as customer service, frequency/loyalty programs, customization, rewards programs, and community building.
- The programs designed to enhance the relationship with existing customers are implemented. Sometimes sales people may feel they are asked to change from a "hunt and kill" mode to a "tend the farm" mode (Nairn, 2002). It means that progress in these programs will be monitored closely and results will be measured.
- Operations people, beware! The marketing literature doesn't say much about "how" the customer is better served. They stress the need for customer service but do not always expand on its content. Sometimes, "inventory" slips into a diagram but there is not much space devoted to its role. Greenberg (2004) gets around to the supply chain in Chapter 15 of his very comprehensive book about CRM, but seems to consider it as not terribly exciting.
- The CRM program develops a set of metrics to measure the results and to revise, modify, discontinue and revere the marketing initiatives that have been introduced (Crandall, 2006).

CRM encompasses functions and features previously found in sales-force automation tools but also adds the ability to perform post-sales support, service and customer maintenance (Darrow, 1998).

Objectives (Reasons for Adopting Program)

While CRM implementation needs technology to be successful, it is the process and people issues that will make or break a CRM implementation.

Factors that have contributed to the rise of CRM include: the splintering of mass media, increased sophistication of consumers and the growth of business intelligence technology. Most companies try to implement CRM but may still measure success based on acquisition instead of retention, revenue instead of profitability, or product-level success instead of customer-level success. CRM relies on people who can apply technology to business imperatives, such as acquisition, retention, and cross-sell. The responsibility for CRM should reside in the marketing department. The data required for CRM should combine that which is in marketing as well as inputs from other corporate systems. Limiting the amount of data and the level of detail will improve the chances of making CRM work. A key challenge of implementing CRM is knowing when to aggregate data for reasons of simplicity and when to keep the data granular. The main CRM applications of data mining are segmentation and predictive modeling (Hill, 1999).

Early adopters of customer relationship management (CRM) systems came to view the technology as just another overhyped IT investment whose initial promise would never be fulfilled. In recent years, system sales are rising, and executives are reporting satisfaction with their CRM investments. Rather than use it to transform entire businesses, they've directed their investments toward solving clearly defined problems within their customer relationship cycle. Four questions all companies should ask themselves as they launch their own CRM initiatives are: (1) Is the problem strategic? (2) Is the system focused on the pain point? (3) Do we need perfect data? (4) What's the right way to expand an initial implementation (Rigby, 2004)?

How did CRM get started? One driver was global competition, which forced many companies to become more customer-oriented as a means of securing a competitive advantage. Progressive businesses want to become "customer-centric." Many expressed this as simply formalizing their ever-present "caring for the customer;" however, a number of people viewed it as a blending of capabilities not heretofore available. A host of IT technologies made it possible to collect and analyze data about customers, and then to translate that knowledge into meaningful marketing strategies (Crandall, 2006).

Another driver was the need for ERP vendors to find new products to sell. After the dizzying burst of ERP implementations leading up to Y2K, it became apparent that the next wave of software implementations was in supply chain management (SCM). SCM offered a bonanza of applications that included CRM, along with other processes that needed software and implementation consulting help. While specialist vendors developed CRM software, the major ERP vendors (SAP and Oracle) are selling extensions of their ERP packages that include CRM software (Bois, 2006).

History (Time Line, Reasons Originated, Principal Developers)

Figure 12D.1 shows the number of articles published about CRM, beginning about 1995. The articles are overwhelmingly from trade publications. They peak about 2001, and appear to be declining as CRM programs reach a more mature state. While there are a number of scholarly articles, they also may have peaked. This may reflect the lack of quantitative elements in CRM programs, often an attraction to scholarly researchers, or it may mean that CRM is morphing into a new phase, such as in internet-related programs. Prompted, in part, by the highly publicized failure of customer relationship management (CRM) initiatives, academic research on CRM has begun to flourish. While the number of articles about CRM may have declined from its peak, there is still an active interest in the subject in that 200–300 articles are published each year, about 75% from trade publications.

Customer relationship management is emerging as one of the hottest applications in business software. Although those who use CRM software have to consider its purpose and overall strategy, once a company makes those decisions, it must consider the type of software best suited to its needs. Another concern is integrating software packages with the current

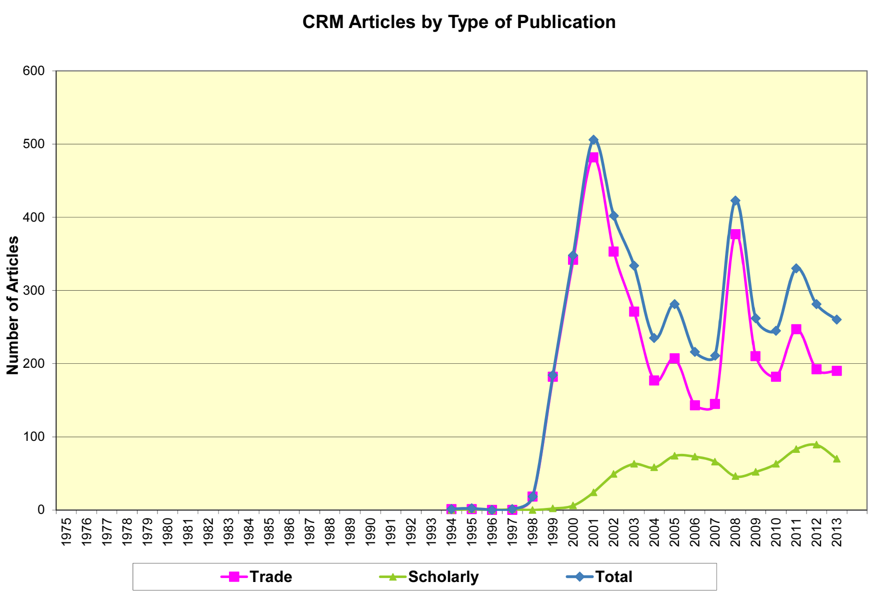

Figure 12D.1. Total number of CRM articles.

system. CRM software offers an updated, methodical way to maintain customer relationships—a new trick to make that old hat fit a little better (Elliott, 2000).

Front- and back-office systems, analytical systems and the Internet have become relevant to customer relationship management (CRM). Some of the more interesting CRM developments are taking place in the e-commerce domain. E-CRM indicates Internet reintermediation; it reverses the early-to-the-Web disintermediation trend that eliminated the human component of the Web-based customer relationship without adequate replacement (Grimes, 1999).

Expected Benefits (Tangible and Intangible)

Everyone, it seems, is talking about customer relationship management. The arguments for CRM are extremely persuasive. The technology can integrate all customer data into one system and allows the organization to become totally customer-focused. Every part of a company knows all about every customer, with the integration embracing new channels. The result of CRM is that existing customers remain loyal and new customers are attracted by the high-quality service.

The primary benefit of a CRM program is increased customer retention. Winer (2001) reports on a study by McKinsey demonstrating that customer retention has greater value than customer acquisition. Businesses should expect to see improved financial results from their CRM program (Lambert, 2006; Kennedy, 2004).

In addition to the tangible benefits, there are intangible benefits. The relationships with customers should be more open and effective. Hopefully, things will go smoothly; however, if there are incidents, the closer relationship should help in their resolution.

Internally, the need to develop cross-functional programs should increase the collaboration among internal functions. Even without considering the operations functions such as purchasing, production, distribution and inventory management, there is a need to get sales, marketing and IT people more comfortable with one another. Nairn (2002) highlights the difficulty in communication between the "emotions-driven sales force and the clinical binary-driven IT expert" as difficult unless intelligently managed (Crandall, 2006).

Barriers to Acceptance

The potential of customer relationship management (CRM) to add value has captured management's imagination, while actual success has proven difficult and elusive. The power of CRM systems rests in the application of data and knowledge for downstream value creation. Understanding that analyzing and understanding customer behaviors and characteristics is the foundation of the development of a competitive CRM strategy highlights the power collaboration can yield. Innovation aimed at enhancing the relationship a firm has with its customers has become commonplace and is an often heard mantra of the executive leadership team within companies (O'Reilly, 2009).

Customer relationship management (CRM) is an important concept to maintain competitiveness at e-commerce. Thus, many organizations hastily implement eCRM and fail to achieve its goal. The CRM concept includes product designs, marketing attributes, and consumer behaviors. This requires different approaches from traditional ones in developing eCRM. Requirements engineering is one of the important steps in software development. Without a well-defined requirements specification, developers do not know how to proceed with requirements analysis. (Wu 2009)

Why have CRM programs not been more successful? It would be easy to blame the software vendors for "over-hyping" their product, but that does not excuse the companies that bought the software from doing their part. In a very readable book, Keiningham et al. (2005) describe 53 myths they attribute to customer loyalty programs. These myths include a number of promises that have not been met satisfactorily in practice.

One of the leading problems has been the myopic view of CRM in considering it an IT technology and not a strategic process. It is not enough to create a database of customers, no matter how cleverly designed. Another limited-scope problem has been to consider CRM as just a marketing program. While marketing is the driver, they need cross-functional support from the rest of the organization.

Sometimes, businesses design the program around what they think they can do (their capability) rather than around the needs of the customer. As a result, they may be efficient at doing the things that the customer doesn't care about or respond to.

Some companies fail to get the support within their organization for the CRM program. Sales may not like the closer monitoring, finance may not agree with the deployment of resources, operations may feel left out, and IT may resent the cavalier attitude toward their innovative systems design.

Companies may try to do too much too soon. Most researchers advocate a selective approach to implementation of CRM.

Customers may be "turned off" instead of "turned on." Most customers want some, but not excessive attention. While subtlety is not generally associated with marketing efforts, it may be a trait to cultivate in CRM (Crandall, 2006).

Implementation Approach

Winer (2001) suggests a seven-stage program for CRM implementation:

- Create a customer database. This should include transactions history, customer contacts, descriptive information for segmentation purposes, and customer response to marketing initiatives or direct contact.
- Analyze the data to classify the customers by their expected lifetime customer value (LCV), or future profitability. The LCV has replaced simpler segmentation by products purchased or demographic information, such as income, location, and age.
- Select the customers for which marketing programs will be developed. Identify the customers with the greatest profit potential to retain as well as customers who are unprofitable, either to convert or remove.
- Design marketing programs for the targeted customers. Design customized marketing programs such as telemarketing, direct mail, and, when appropriate, direct sales. Avoid mass marketing such as television, radio, and print advertising, which are used for creating brand awareness but not for CRM purposes.
- Develop customer relationships. These are programs to develop closer relationships with the customer. They can include direct customer service, loyalty programs, product and service customization, and community building.
- Pay attention to privacy issues. While compiling information about customers may help a company provide more individualized service, it may also irritate the customer, causing them to respond negatively, or even to discontinue buying from the company.
- Develop appropriate metrics to evaluate the CRM program. While traditional measures such as profitability, market share, and profit margins will continue to be important, some newer CRM measures include customer acquisition costs, conversion costs (from lookers to buyers), retention/churn rates, same customer sales rates, loyalty measures, and customer share of a category or brand.

For the most part, users have not always been ecstatic about their results. Many have failed to realize the "perfect order" status heralded by CRM proponents. Chan (2005) cites a Meta Group study that reports a 55 to 75% implementation failure rate. Lambert (2006) reports that, according to the Gartner Group, 55% of all customer relationship management (software solutions) projects do not produce results. In a Bain Survey of 451 senior executives, 25% reported that these software tools failed to deliver profitable growth and in many cases damaged long-standing customer relationships.

From its origin in the mid 1990s, CRM had a burst of popularity until 2000, when it fell into decline because of limited success and tighter IT budgets. After a low point about 2004, it is suddenly in vogue again. Compton (2004) predicts renewed growth, particularly in nontraditional service areas, such as government and education. One reason for the renewed interest is that many supporters conclude that CRM is not just a marketing program; it is an essential part of the modern supply chain (Crandall, 2006).

Future

CRM research supports the conclusion that it is a management "fashion" and not a "fad." It should have great appeal in service industries, such as banks (Giltner & Ciolli, 2000), public accounting (Hayes, 2006), and insurance (West, 2001). Electronic CRM has great promise. Feinberg (2002) reports on the progress in retailing. Shah and Murtaza (2005) provide, in great depth, the use of Web services to achieve effective CRM.

IDC reports that there were 190 CRM vendors covering 49 countries in 2011. The three largest vendors were Oracle, Salesforce.com and SAP, all companies with demonstrated track records in CRM. The top 10 vendors represent 49% of the CRM applications. (IDC 2012) Obviously, these vendors consider CRM to be a promising market.

CRM has had a short and sometimes turbulent life. However, it appears to be a program that companies are finding beneficial, if not essential, to their future existence. One of the big challenges that face companies is the issue of how to include data analytics technologies in their future CRM programs.

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CHAPTER 12E

SUPPLIER RELATIONSHIP MANAGEMENT (SRM)

NAME AND BRIEF DEFINITION

Supplier Relationship Management (SRM)—A comprehensive approach to managing an enterprise's interactions with the organizations that supply the goods and services the enterprise uses. The goal of SRM is to streamline and make more effective the processes between an enterprise and its suppliers. SRM is often associated with automating procure-to-pay business processes, evaluating supplier performance, and exchanging information with suppliers. An e-procurement system often comes under the umbrellas of a supplier relationship management of family of applications (Blackstone, 2013).

Table 12E.1 shows some of the major processes and activities in SRM. The processes listed show the challenges for companies that want to develop SRM programs over a wide range of suppliers.

Manufacturing companies have been chasing cost savings since the industrial revolution brought workers into factories equipped with powered machinery. Automation has attacked the labor content to the point where, in most industries, labor is a relatively small contributor to product cost. That leaves purchased parts and materials as a target for new cost saving initiatives, which has companies addressing what has become known as supplier relationship management (SRM). SRM encompasses much more than simple purchase order release and vendor performance measurement. Just as customer relationship management grew from

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Table 12E.1. SRM Processes and Activities

Supplier Relationship Management (SRM)	
Strategic Sub-Processes	*Activities*
Review corporate, marketing, manufacturing and sourcing strategies	Identify product and service components that are key to the organization's success now and in the future
Identify criteria for segmenting suppliers	Choose appropriate criteria: profitable/growth/stability, technology, capacity, innovation, quality, volume purchased, criticality/service level required, sophistication/compatibility
Provide guidelines for the degree of customization in the product and service agreement	Consider quality/cost implications of various differentiation alternatives: select boundaries for degree of differentiation
Develop framework of metrics	Outline metrics of interest; relate metrics to the supplier's impact on profitability and the profitability for the supplier
Develop guidelines for sharing process improvement benefits with suppliers	Outline options for sharing the benefits of process improvement

Source: Adapted from Lambert (2006).

order entry to a comprehensive suite of applications aimed at effective management of the entire customer relationship, SRM takes the same approach on the supplier side (Turbide, 2002).

Objectives (Reasons for Adopting Program)

Customer relationship management (CRM) is a program designed to create more effective relationships with customers. On the other end of the supply chain, supplier relationship management (SRM) programs are designed to create more effective relationships with suppliers.

SRM requires a medium to long term strategy and a comprehensive set of tactics and tools. These must be supported by top management and involves other functions in a business. Cross-functional teams must work together. However, procurement should take the lead to create a consensus on the value and approach among key stakeholders within the business (Gilbert, 2006).

Manufacturers and their suppliers are moving from traditional adversarial relationships characterized by price haggling and hedging bets on product orders in favor of a collaborative model designed to be mutually beneficial. To assure these new alliances, vendors are using enhanced supply-chain planning and forecasting tools and SRM technologies that provide real-time access to the demand, inventory, price, sourcing, and production data to be shared by manufacturers and their suppliers. This evolving collaborative approach has resulted from the balance of power in business relationships shifting to the customers, whether manufacturers or end-users (Harreld, 2001).

Purchasing is the key contact between external suppliers and internal functions creating and delivering value for customers. While dealing at arm lengths is perfectly suitable for some suppliers, others should be treated as close partners. A SRM program should help in integrating such different types of suppliers into appropriate relationships (Moeller, Fassnacht, & Klose, 2006).

The aim in implementing SRM technology should be less about negotiating price reductions than about creating closer collaboration with key suppliers. One of the reasons for the success of Japanese car manufacturers, such as Toyota, is the exceptionally close relationship they have with their suppliers. Most good companies, with their partners and suppliers, will attempt to work with their suppliers to arrive at a price structure that is acceptable to both parties (Thomas, 2003).

History (Time Line, Reasons Originated, Principal Developers)

Figure 12E.1 shows the number of articles published about supplier relationship management (SRM). The program employing the acronym is a recent development, with the articles starting about 2000. SRM is a program closely associated with supply chain management (SCM) and customer relationship management (CRM) programs, which are also designed to develop effective relationship with other supply chain participants. While the number of CRM articles range between 200 and 300 per year, SRM articles are in the ten to twelve articles per year.

To date, the articles have been predominantly in trade publications and, even there, only a few. Academic publications tend to lag those in the trade journals, so perhaps there will be an increase in scholarly articles as researchers begin to probe more deeply into SRM programs.

SRM is still in its early days. Many organizations have not seriously addressed it at all, but among those that have, there is often the view that it is somehow soft and based on personal relationships rather than a hard-edged business tool that can and should deliver real value. As a supplier's operation becomes integral to the organization, activities around management of the contract and supplier become critical. SRM means man-

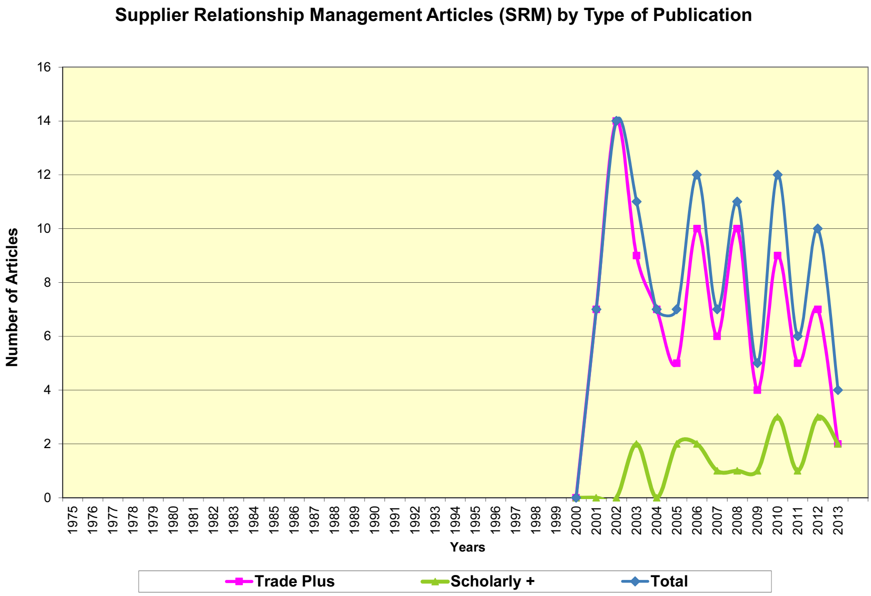

Figure 12E.1. Total number of SRM articles.

aging the entire interface between suppliers and the buying organization (Smith, 2005).

The growth of offshore outsourcing has made the need for close supplier relationships more important. This aspect of supplier relations is probably written about more in supply chain management or outsourcing articles than in SRM articles.

Expected Benefits (Tangible and Intangible)

The importance of SRM is not new, but the theory is undergoing somewhat of a change. Good SRM can lead to cheaper prices, faster time to market, more flexibility and innovation. However, what is changing is that as businesses refine their supply base, the remaining vendors are becoming more powerful. If the relationships with these fewer, stronger suppliers are not managed properly they could present a risk to the business. Most competitors are roughly equal so supplier relationships can give a company a sustainable competitive advantage. Good supplier relations will generate more savings than costs. It is usually up to buyers to determine the nature of the relationship; suppliers can only react (Ellinor, 2007).

Provided suitable attention is paid to security issues, SRM offers a quick way to tangible benefits. SRM improves the relationship between customers and suppliers and gives procurement managers greater control over their transactions. Suppliers can continually update delivery schedules and stock levels, and make better predictive plans because they know more about the procurement manager's needs, while the procurement manager can achieve more reliable deliveries and better economies of scale (Gurton, 2001).

When customers collaborate with suppliers, both can build trust, reduce relational stress, and increase innovation-related activities. Two innovation-related supplier activities that have particular impact on the customer are: (1) investing resources in technology to create innovative products or processes that could support potential future business with the customer; and (2) sharing technology with a customer without the assurance of a purchase order. Both of these activities indicate a supplier's commitment to the relationship that goes beyond a simple calculation of the current costs and benefits, and can assure future business with the customer. Most important, these innovation-related supplier activities help a customer establish a competitive and reliable supply chain. Supplier commitment provides a basis for both the customer and the supplier to build confidence in the stability of their working relations and to act toward each other in an increasingly trusting manner (Henke & Zhang, 2010).

The trend towards outsourcing non-core activities means that most supply chains are more complex and expensive to run than ever before. One report found that 68 per cent of companies said their supply chains had become more complex in the last three years, while 64% said their supply chains had become more geographically dispersed. Supplier relationship management (SRM) software is designed to provide companies with greater control over their supply chains. These products enable customers to integrate suppliers with their supply chain, facilitate the exchange of information, eliminate inefficiencies and reduce external expenditures. For the customer, the benefits are obvious. But what about suppliers? If your main aim is to reduce costs, how can you convince suppliers that SRM software also works to their advantage? Suppliers tend to be skeptical, because often vendors perceive SRM-like programs as meaning they will be squeezed on price (Thomas, 2003).

Gilbert (2006) reports an Accenture survey revealed firms that actively managed suppliers were able to respond quickly to market changes, deliver the right product and services, and increase value. Procurement departments can deliver benefits when they work with other functional departments and suppliers.

Barriers to Acceptance

SRM means different things to different people. BP started its SRM program in 2003 and Bill Knittle, global procurement director, refining and marketing segment, says he has the "battle scars" to show for it. He believes SRM programs require about 70% behavioral change and 30% process adjustment. He said buyers had to send clear and consistent messages to suppliers and set key performance indicators (KPIs) appropriate to the relationship—for example, with top targets around innovation measurement for only your tier one suppliers. Joseph Youseff, director of global technology supplier management at McDonald's, believes executive sponsorship has been a key to the success of SRM at McDonald's and says some of its suppliers have also appointed an executive sponsor to mirror the behavior. Conventional project sponsorship achieves only short-term goals (Ellinor, 2008).

Most discussions and articles about supply chain metrics are, in actuality, about internal logistics performance measures. The lack of a widely accepted definition for supply chain management and the complexity associated with overlapping supply chains make the development of supply chain metrics difficult. Despite these problems, managers continue to pursue supply chain metrics as a means of increasing their visibility over areas they do not directly control, but have a direct impact on their company's performance. The problem is in managing the interfaces between customer relationship management and supplier relationship management processes at each link in the supply chain. The translation of process improvements into supplier and customer profitability provides a method for developing metrics that identify opportunities for improved profitability and align objectives across all of the firms in the supply chain (Lambert & Pohlen, 2001).

Another common but difficult to resolve obstacle is the lack of trust between customers and suppliers. Interfirm supply chain relationships can be an important driver of firm performance and sustainable competitive advantage. Successful supply chain relationships can reduce costs, increase service, and improve financial performance. However, to truly leverage the power of collaborative supply chain initiatives, relationship partners must trust each other (Thomas & Skinner, 2010).

Suppliers, particularly smaller ones, may be reluctant to make changes to their own systems and processes to adapt to the customer if the end result is to force a price reduction. Unless there are very clear benefits for them in the new system, any extra cost is going to be added to the price they charge. In addition, they are unlikely to perceive software that is designed to manage them as being to their advantage. Rather than making price concessions the primary focus, a better approach may be to explore the processes used by both customer and supplier to identify changes that could lead to lower costs, and subsequently, lower prices (Thomas, 2003).

Steve Singleton believes SRM remains relatively undeveloped; however, companies are beginning to focus more attention on it. He lists poorly defined processes, decentralized sourcing and procurement responsibilities, and a lack of investment as major inhibitors in SRM progress. Paul Alexander agrees with Singleton. "The skills buyers are trained in are not necessarily the same as those in SRM, which takes a longer-term perspective and concentrates on soft skills" (Gilbert, 2006).

Another obstacle is that the current incumbents in procurement jobs may not be able to make the transition to the new concepts. Those who have been working at the transaction level and taught to be aggressive with suppliers may not adapt to building long-term relationships with mutual sharing responsibilities (Ellinor, 2008).

Implementation Approach

According to Gilbert (2006), SRM leaders have included the following features in their SRM programs:

- Supplier segmentation: identifying the right buyer-supplier relationship to form part of the strategic sourcing process
- Contract management: enabling comparative analysis and the monitoring of contract compliance
- Supplier performance management: the monitoring of suppliers' operational, administrative and cost management performance
- Integration and collaboration: integration relates to systems integration with key suppliers, allowing for more streamlined planning and fulfillment. Collaboration related to joint improvement planning.

These should be underpinned by:

- An organizational structure where SRM becomes a critical function and the procurement's department cross-functional team efforts are institutionalized and encouraged.
- The right people whose skills are developed and deployed and are focused on working more closely with key suppliers to deliver value for both the supplier and their own organizations over time.

- The right technology to capture and assimilate supplier specific information and data (Gilbert, 2006).

Smith (2005) provides the following suggestions for implementing a SRM program:

- If you don't have the basic performance management processes in place, don't think about SRM.
- Make sure you're prioritizing carefully which suppliers to address.
- Be clear about the objectives; they should clearly relate to your organization's overall aims.
- Consider what the supplier wants of the relationship and position your objectives accordingly.
- Don't underestimate the resources needed to do this well.
- Data is important—don't be obsessed with it, but you will need a clear view of your business with the supplier and spend patterns.
- Involve key internal stakeholders—SRM can't be a purely procurement-based activity.
- Consider who is best placed to handle different—day-to-day versus long-term—aspects of SRM.
- Be creative—there are many different techniques, tools and processes that can be useful in these programs.
- Even your closest partner may not meet your needs in the future—or may decide to become a competitor, or withdraw from your business.

Some of the steps critical to successful SRM include:

- Issue a management mandate: Make sure your company wants to do SRM.
- Provide global supply relationship managers with adequate skills and passion.
- Establish behavioral norms. Insure internal alignment and manage stakeholders.
- Realize quick wins to motivate and create long-term values.
- Establish mutual interest and relationship targets.
- Don't wait for the right time to start—it will never happen; just start.
- Measure performance—have joint targets to increase productivity or mitigate risk (Ellinor, 2007).

Future

SRM will continue to grow in importance as it becomes more understood and companies are able to adapt the concept to their organization. While procurement can take the lead, SRM must be viewed as a holistic approach with cross-functional teams working together to develop working relationships with cross-functional teams in supplier organizations.

Some managers view SRM as the next core competency and a source of competitive advantage. The SRM domain involves relatively wide and complex business processes and without the support of IT, it would not be accomplished easily. This suggests the need of an e-SRM installation. As the Internet became popular, many firms were quick to launch e-SRM. However, the fundamental issue is in the determination of user requirements, commonly considered to be the key to the success of the system installation and often inappropriately planned.

The current view of SRM is that it is relevant and important to today's businesses. "Increasingly, supplier relationship management (SRM) is being viewed as strategic, process-oriented, cross-functional, and value-creating for buyer and seller, and a means of achieving superior financial performance" (Lambert & Schwieterman, 2012, p. 337). The authors go on to explain that both CRM and SRM are critical links in the supply chain and supply chain management is about managing relationships

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CHAPTER 12F

PRODUCT LIFECYCLE MANAGEMENT (PLM)

NAME AND BRIEF DEFINITION

Product life cycle management (PLM). The process of facilitating the development, use, and support of product that customers want and need. PLM helps professionals envision the creation and preservation of product information, both to the customer and along the reverse-logistics portion of the supply chain (Blackstone, 2013).

Product life cycle management or product lifecycle management (PLM) is a relatively new acronym in the management program literature. Articles began appearing in 2000 and have steadily increased during the past few years. There are articles that use "life cycle" and some that use "lifecycle"; it is difficult to see that there is an accepted difference in meaning. One source does make the following distinction between the two terms. "Product Lifecycle Management (PLM) is more to do with managing descriptions and properties of a product through its development and useful life, mainly from a business/engineering point of view; whereas Product life cycle management (PLCM) is to do with the life of a product in the market with respect to business/commercial costs and sales measures (Wikipedia, 2008). We will use lifecycle (one word) in this program description.

Sussman (2002) defined product lifecycle management as "the marketplace name for the comprehensive framework of technology and services that permits extended product teams—inside and outside of an enter-

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prise—to collaboratively conceptualize, design, build, and manage products throughout their entire lifecyles." This definition pointed out two primary objectives of PLM—a technology to manage information and a concept to promote collaboration among departments within a single company or between separate companies.

Swink (2006) expands the scope of PLM and distinguishes between PLM as a management process and a PLM system. The system is a collection of hardware and software technologies that support PLM, and generally available to design and manufacturing engineers. The PLM management process extends the functionality to include customer relationship management (CRM), supply chain management (SCM), and enterprise resource planning (ERP). This links product data with customer data, processing data, cost data, and resource planning data, and makes this data accessible to everyone within the firm, as well as customers and suppliers.

Objectives (Reasons for Adopting Program)

As the name implies, PLM includes the use of product information not only during its research and design stage but also during its production, post-sale service, and recycling stages.

Gould (2003) described it this way. "What's in a product lifecycle management (PLM) system? Some authoring tools, computer-aided design (CAD); large dollops of simulation and visualization; lots of manufacturing data systems (e.g., computer-aided process planning (CAPP) and configuration management); heavy-duty infrastructure stuff (database management systems (DBMS) and data communications); and plenty of behind-the-scenes infrastructure utilities, such as web-based user interfaces and application programming interfaces (API)."

Another description of PLM lifecycle information "can include design data and material lists from suppliers and their suppliers; bills of material and their many derivatives and revisions; design-for-manufacturing input; revisions history, notes and source data; marketing and sales input; cost accounting data; test and performance criteria; manufacturing process requirements; as-built information, including quality assurance data; regulatory compliance confirmation and certification; and service and use history" (McClellan, 2006).

PLM has three core components. Authoring includes the mechanical, electrical and software design aspects. Visualization lets users collaborate across a wide range of participants in real time. Business process support provides a wide range of data about the product unit or batch during and after manufacturing that lead back to authoring. "CAD systems and other authoring tools have been available for many years. It's the extended cradle-to-grave view of the product that makes PLM a useful business tool, expanding horizontally to include wider participation and vertically to include data from more of the processes and events that make up the product lifecycle" (McClellan, 2006). McClellan goes on to say he believes that PLM handles the first two components well, but will need additions of business process management (BPM) and service-oriented architecture (SOA) to fully support the third component.

History (Time Line, Reasons Originated, Principal Developers)

The program started out as an extension of CAD to include electronic data sharing capabilities among users, both internal and external to a company. PLM has grown rapidly to become a strategic initiative that parallels SCM as a global management concept.

CAD has been a well-accepted technology for several decades. It captures a great deal of data about products and it was natural to want to make this data available to downstream participants in the product design and production processes. Computer-aided manufacturing (CAM) enabled the product design to be connected with the production process and use applications of computer numeric control (CNC) to reduce product development times and production costs.

CAD was also linked with computer-aided engineering (CAE) which is the "process of generating and testing engineering specifications on a computer workstation" (Blackstone, 2013). It linked with product data management (PDM) systems used to track bills of materials and product revisions.

As the amount of data about products accumulated, it was natural to recognize that new computing and data transmission capabilities could make the engineering data available, in a variety of formats, to downstream users. Thus, the concept of PLM was born. Figure 12F.1 shows the number of articles written about PLM. The topic is a relatively new one, beginning in the early part of the twenty-first century and apparently still in the formative stages of a management program. Most of the articles have been in trade magazines with researchers only recently showing an interest in scholarly journals.

As time passed, PLM, like most management programs, became more holistic. From its beginning as a technology extending CAD, it is now a strategic initiative that some consider even broader than other global programs, such as supply chain management.

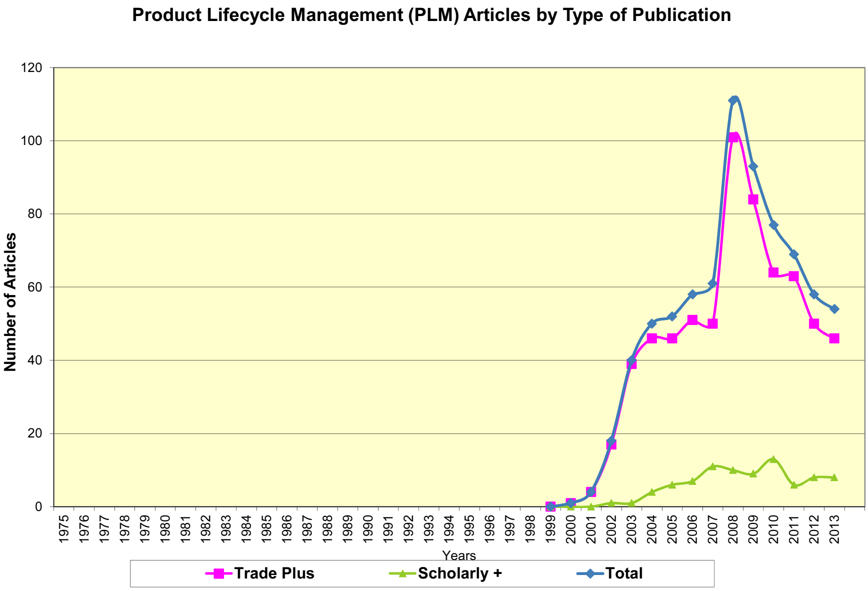

Figure 12F.1. Total number of CRM articles.

One author lists the following phases as within the scope of PLM: Requirements, portfolio management, planning, conceptual design, product engineering, manufacturing engineering, simulation validation, build and produce, test and quality, sales and distribution, in-service operation, maintenance and repair, and disposal and recycling (Gould, 2005).

PLM does not include the planning and execution of the strategies and tactics to maximize market presence; the commercial or transactional activities related to ordering, shipping, and fulfilling orders, or payments (that's ERP); the assigning of factory floor resources, managing material flows, task scheduling, line balancing, or equipment maintenance scheduling (that's MES); and the automation of customer or prospect databases (Gould, 2005).

For our purposes, we will exclude the information that deals with the actual sale and production of a product's flow within the supply chain, such as in sales and operations planning, production planning and scheduling, purchasing, and distribution. This is a parallel information flow and, like PLM, under the umbrella of supply chain management.

Expected Benefits (Tangible and Intangible)

PLM started in the aerospace and automotive industries. The automotive industry wanted faster product development and the aerospace industry wanted improved planning of repair and maintenance needs for spare parts. Boeing is an effective user of PLM with their 787 Dreamliner and Toyota is the most progressive user of PLM in the automotive industry (Waurzyniak, 2006).

An early study by AMR found benefits in three areas: (1) infrastructure savings, through the elimination of redundant manual data entry and deliveries of hard copies through couriers; (2) reduction of operating costs, usually within six to twelve months after companies go live with PLM; and (3) strategic competitiveness impacts, such as in time to market, market share, and gross margins, usually in three to five years (O'Marah, 2003).

Another industry that embraced PLM is consumer-packaged goods because of the pressures to increase revenues and improve operating efficiencies. As supplements to PLM, they adopted product data and pack management, portfolio management, product requirements management, collaborative product design and visualization, and functional design integration. As a result, they achieved benefits, such as faster time to market; longer, more profitable product life; reduced product development and production cost; increased product lifecycle margins; improved product quality; increased development capacity; improved customer service and satisfaction; rapid quoting/responses; increased component reuse; increased enterprise use of PLM data in marketing and sales; and better supply chain relationships (Nelson, 2006).

There are reports of more novel PLM applications. Jimmie Johnson, winner of the six NASCAR Cup Championships owes some of his success to his team's use of PLM to track where and how parts are used, and how to adapt to manufacturer's design changes (Bartholomew, 2007). Sutton (2007) found that the NASCAR teams for Evernham Motor Sports, Joe Gibbs Racing, and Hendrick Motor Sports, found PLM to be a valuable addition to their set of tools. One benefit is that simulation techniques will reduce the need for expensive and time-consuming aerodynamic testing in wind tunnels.

PLM will aid in meeting FDA compliance requirements for medical device manufacturers. ArthroCare Corp., a manufacturer of minimally invasive surgical products, implemented a PLM program in 2003 to help streamline its product development process. They report that the implementation reduced record-keeping and improved document control by making data available in real time across all the company's sites (Jusko, 2006).

The conclusion by most writers is that cost reduction benefits come faster but may not be sufficient to justify the expense. However, the real payoffs come later, in three to five years, by producing revenue increases that would not materialize without the use of PLM.

Barriers to Acceptance

If PLM is so great, why isn't everyone using it? As with many new programs, a number of obstacles prevent companies from quickly adopting it. PLM is complex because of a "variety of functional experts, large numbers of suppliers across many tiers, vast quantities and types of data, and high rates of product introductions and change" (Conner, 2004). He suggests that many PLM initiatives fail because they do not avoid six common traps: (1) lack of a complete vision; (2) not having a business case; (3) failure to construct a business release approach; (4) making PLM a departmental initiative; (5) placing too much burden on application software; and (6) no owner of the product lifecycle.

In a study of collaboration building, Swink found 80% of companies were dissatisfied with their collaborative development efforts for new products. He identified four barriers that prevented effective relationships:

- Physical and temporal barriers impede real time, rich communication among team members. While technology is available, there is a need to design the timing and make-up of team structures to foster balance among the product design objectives of the team members.
- Organizational and hierarchical barriers. Standard operating procedures often create functional barriers that must be broken down. It may be necessary to realign reporting relationships and reward structures. Collaboration is more difficult if it includes multiple companies.
- Relational barriers. Individuals may be unwilling to collaborate due to a preconceived loss of power or status. It may be difficult to find employees who have both the technical and personal skills to work effectively in a collaborative environment.
- Knowledge barriers. Although the technical means to communicate may exist, and the team organization may be adequate, there is a final need to develop and classify knowledge and knowledge retrieval systems to make collaboration a reality (Swink, 2006).

Conner (2004) warns that PLM has grown up as an engineering concept and, in many cases, supply chain professionals have not been included in product lifecycle initiatives, nor have representatives from sales and marketing. If PLM is to succeed, it must expand its scope by including all functional areas of a business.

Companies are finding that PLM technology is coming along quickly, although it is still a long way from being a completely integrated package.

While the technology exists, there is a need to alter the infrastructures and cultures of companies to make PLM a complete success.

Implementation Approach

In his book, *Product Lifecycle Management, Driving the Next Generation of Lean Thinking*, Michael Grieves (2005) provides a comprehensive discussion of how a PLM program is conceived and implemented.

- Begin with a vision of tomorrow. Without it, inertia sets in and a business makes no progress.
- PLM is a strategy, not a goal. It is an enabler to achieve some of the goals of an organization.
- Realistically assessment today's situation. How close are you to achieving a "One Company" view, as opposed to coping with functional silos?
- Develop a plan for bridging the gap between where you are and where you would like to be, as regards people, processes and practices.
- Determine the resources required. No matter how necessary it is to achieve the goal, the reality is that capability and resources either constrain or enable the strategies pursued.
- Evaluate the impact of the PLM strategy. What are the tangible benefits? The intangible benefits?
- Evaluate the lessons learned in implementing a PLM strategy
- Top management must be engaged, not just involved
- Product leaders are veterans and team members are decision makers
- Third parties fill gaps in expertise and transfer knowledge
- Change management goes hand in hand with project management
- A satisficing mindset prevails
- Suggestions
- Find PLM initiatives to support corporate objectives
- See beyond functional barriers
- Watch for optimal decisions that are suboptimal
- Stretch change muscle
- Think "One Organization"

Even though PLM can support individual program efforts, it provides the greatest benefit when there is a strategy that coordinates all the organization's efforts.

Future

The status of PLM implementations is mixed. Conner (2004) reported, "Many product lifecycle management (PLM) initiatives have fallen short of their great expectations." Swink (2006) concludes, "A comprehensive PLM system has not been developed," although steady progress is being made. Teresko (2007) reports "PLM is not just a set of technologies, but a strategic business approach that integrates people, processes, business systems and information." Thilmany (2007) found that companies have still not adequately linked PLM to their manufacturing execution systems (MES) so information can easily move back and forth from engineering to manufacturing.

In many technology innovations such as PLM, the potential leads the actual. As new applications for PLM emerge, the realization of all the possibilities by any one system or company recedes. No single company does all of the things that PLM designers envision. While this does not diminish the potential, it does mean that it is more difficult to choose the specific components or applications of PLM that will be the most beneficial for a company.

The pieces that make up a PLM system exist; the task is putting them together into an integrated system and then introducing that system throughout a company's series of supply chains.

PLM has come a long way in a short time as a business tool. Generally, the big players in the global product life-cycle management (PLM) market have performed well in the last few years, but no doubt all of them have felt the impact of the global economy. Not immune to economic fluctuations, the PLM growth curve is flattening out. Economic caution has led to fragile spending, which won't change until the world economic recovery is well entrenched (Ogewell, 2014). The size of the PLM market in 2014 was estimated as approximately $35 billion.

While there has been growth in the marketplace, there has also been consolidation among providers. SanFilippo (2007) reports the wave of mergers, acquisitions, and alliances between traditional PLM vendors and suppliers of enterprise software, provides greater opportunities for data sharing and eventual collaboration. She lists examples of this merger trend as Oracle buying Agile Software and Siemens buying UGS. Microsoft also has been involved in several alliances. SAP is extending their strong position as an ERP provider with forays into additional areas such as CRM, SCM and PLM. It appears that further consolidation is likely, much as in the CRM market.

The scope of PLM continues to expand, from a technology to a system to a management concept to a strategic philosophy. Brown (2008) suggests the evolution from CAD to PDM to PLM to PLM 2.0 (the latter he attributes to Dassault Systems' new release that transitions from PLM towards web services and SOA).

There is also the question of where PLM fits into the hierarchy of management programs. Is it going to be the umbrella that covers all other management systems such as CRM and SCM, or will it be a component of a larger concept? Conner (2004) suggests that, in order for companies to achieve increased profitability with PLM, they must tap into supply chain principles and expertise. Swink (2006) portrays PLM as the master system that includes PDM, CRM, SCM and ERP.

The high cost of product lifecycle management (PLM) software was once a barrier to entry for all but the largest of manufacturing operations. However, new versions of PLM software and cloud-based systems are bringing the cost down, allowing more companies to benefit from the technology. Consequently, PLM technologies are becoming more common at smaller to mid-size manufacturers, as lower-cost PLM alternatives including some newer cloud-based systems have become available (Waurzyniak, 2012).

There is little doubt that PLM, as a managerial concept, is important and appropriate to most businesses. However, the fact that it is a desirable objective does not make it any easier to implement successfully.

ACKNOWLEDGMENT

Adapted from Crandall, R. E. (2008). The evolution of product life cycle management. From engineering tool to business concept. *APICS Magazine, 18*(5), 21–23. Used with permission.

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CHAPTER 13A

MANAGEMENT BY OBJECTIVES (MBO)

NAME AND BRIEF DEFINITION

Management by Objectives (MBO)—A participative goal-setting process that enables the manager or supervisor to construct and communicate the goals of the department to each subordinate. At the same time, the subordinate is able to formulate personal goals and influence the department's goals (Blackstone, 2013).

Objectives (Reasons for Adopting Program)

The logic behind MBO is that if the correct objectives can be established, and if employees are aware of and understand these objectives, they will be motivated to achieve the objectives. This is an extension of strategic planning at the organization level, where objectives and strategies are developed for the entire organization and its individual functional areas. MBO extends the objectives to the individual employee. MBO also suggests that, if employees have specific objectives to achieve, their performance can be more objectively evaluated.

History (Time Line, Reasons Originated, Principal Developers)

Peter Drucker is credited with first describing the concept of Management by Objectives (MBO) in his book *The Practice of Management*, pub-

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 469–473
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lished in 1954. He viewed it as an approach that would more closely align the efforts of individual employees with the goals of the business or entity for which the individual worked. As obvious and desirable as this would appear, even Drucker recognized that implementing a MBO program throughout a company would require major changes. In speaking about implementing MBO among managers, he stated:

> Management by objectives requires major effort and special instruments. For in a business enterprise managers are not automatically directed toward a common goal. On the contrary, organization, by its very nature, contains four powerful factors of misdirection: the specialized work of most managers; the hierarchical structure of management; the differences in vision and work and the resultant insulation of various levels of management; and finally, the compensation structure of the management group. To overcome these obstacles requires more than good intentions, sermons, and exhortations. It requires policy and structure. It requires that management by objectives be purposefully organized and be made the living law of the entire management group. (Drucker, 1974)

Bedeian (1986) suggested a number of benefits and problems with MBO, as summarized in Table 13A.1.

MBO was well received by both practitioners and academics. As a result of Drucker's influence and later, with support from George S. Odiorne, many companies implemented MBO programs with varying levels of success. Some of the better known companies included General Electric, Du Pont, RCA, General Foods, Wells Fargo, Purex, and General Motors (Bedeian, 1986). As shown in Figure 13A.1, the number of articles written about MBO peaked in the mid 1970s. The first articles appeared before

Table 13A.1. Benefits and Problems With MBO

Benefits	*Problems*
• Improved communication between superior and subordinate on job content and the relative importance of major duties. • Improved utilization of human and material resources. • Improved subordinate development. • Improved subordinate performance. • Improved criteria for evaluating subordinate performance. • Improved overall planning.	• Inadequate top management support. • Poorly defined objectives. • Inadequate monitoring of progress toward accomplishment of agreed upon objectives. • Inability to modify objectives rendered unreasonable by forces within an enterprise or within its external environment. • Inadequate evaluation of actual accomplishment of agreed upon objectives. • Overemphasis on paperwork. • Too time consuming.

Source: Adapted from Bedeian (1986).

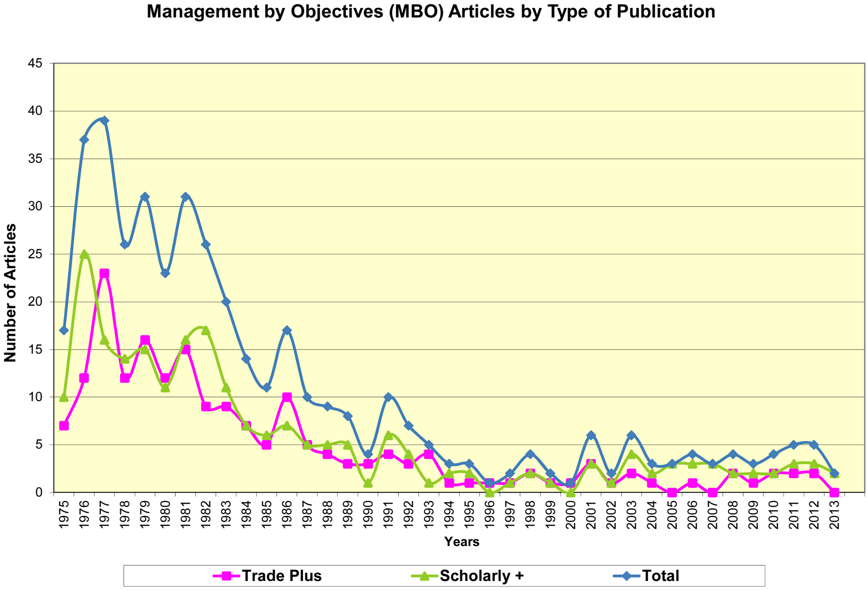

Figure 13A.1. Total number of MBO articles.

1975, about equally divided between trade and scholarly papers. Today, only a few articles are written, often by academics searching for the reasons for MBO's decline or describing how variations of MBO can be used.

Expected Benefits (Tangible and Intangible)

Tangible benefits could include increased revenues, reduced costs, improved quality, faster lead times, or any other objectives that are built into the MBO program.

On the intangible side, a well-run MBO program can facilitate creativity and innovation by: (1) asking for innovation; (2) working at encouraging people to be innovative; (3) getting commitment from individuals and teams; (4) communicating dissatisfaction with the status quo; (5) rewarding innovation; and (6) endorsing and supporting innovation (Odiome, 1979).

Barriers to Acceptance

Although the MBO concept was logical, it was difficult to implement and administer, as Drucker anticipated. Its success corresponded with the prosperity experienced by American companies during the post-World

War II period when there was limited competition from other industrial countries in Europe and Japan because they were rebuilding their manufacturing capabilities. During this period, American companies had the luxury of stable product life cycles and limited price competition. As global competition increased during the last two decades of the twentieth century, new paradigms began to emerge.

Roth (2009) highlights several major changes that have made MBO less applicable to today's businesses.

- There has been a movement away from focusing on individual objectives to focusing on team objectives. The team approach is coming into its own with the need for open access to information, participative decision making, employee empowerment, and a reward system based on team or organizational effectiveness, not individual effectiveness.
- The rate of change in markets, technology, and societal trends is occurring so fast that this year's goals—as defined in the MBO objectives—might be obsolete within a short period of time. Continuing without changing objectives is illogical; however, changing objectives may end up being impractical.
- Measuring individual productivity is becoming more difficult as organizations grow in complexity and interdependency among entities becomes more common. In addition, objectives must include more intangible elements if they are to be realistic, adding to the measurement difficulty.
- Setting specific objectives may stifle creativity. If an individual's performance is to be measured against established objectives, there will be less motivation to spend time trying to be creative—unless creativity is an objective. Creativity may also introduce more measurement difficulties into the evaluation process.
- Closely aligned with the creativity issue, employees may be inclined to ignore any form of new opportunity if it interferes with achieving their assigned objectives. For example, spending additional time to satisfy a customer may be unrewarding to the employee, although it may be very beneficial to the company.

Implementation Approach

MBO is a managerial process by which organizational purposes are determined and met by joining supervisors and subordinates in the pursuit of mutually agreed-upon goals and objectives, which are specific, measurable, time bounded, and linked to an action plan. Progress and goal achievement are measured and monitored in appraisal sessions that focus on mutually determined objective standards of performance (Migliore, 1982). Implementation steps include:

- Define an organization's purpose and reason for being.
- Monitor the environment in which it operates.
- Realistically determine its strengths and weaknesses.
- Make assumptions about unpredictable future events.
- Prescribe written, specific, and measurable *objectives* in principal result areas contributing to the organization's purpose.
- Develop strategies on where and how to use available resources to meet *objectives*.
- Make long- and short-range plans to meet *objectives*.
- Constantly appraise performance.
- Reassess purpose, environment, strengths, weaknesses, and assumptions before establishing *objectives* for the next performance year (Migliore, 1982).

Future

It is unlikely that MBO, as a management program, will be revived from its original state. However, it may be reinvented as some other form of program that provides direction and substance to individuals working within an organization. The limitations of MBO are more in its design than in its concept.

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CHAPTER 13B

STRATEGIC MANAGEMENT AND STRATEGIC PLANNING

NAME AND BRIEF DEFINITION

Before strategic planning came into favor in the mid-1960s, companies survived with informal planning processes (Mintzberg, 1993). For example, many business founders directly managed their companies without needing formal plans because those organizations were small and the owner-managers could convey goals and strategies directly to employees. Even today, some small businesses use informal planning approaches (Meers & Robertson, 2007).

The increase in business size and complexity made it necessary to have a more formal process for developing and disseminating strategies (Chandler, 1977). Consequently, strategic planning arose as a normal part of managing an organization. While strategic planning is widely accepted as a theoretical concept, it has not been as effective in practice (Mintzberg, 1993).

Strategic plan—The plan for how to marshal and determine actions to support the mission, goals, and objectives of an organization. A strategic plan generally includes an organization's explicit mission, goals, and objectives and the specific actions needed to achieve those goals and objectives. See: business plan, operational plan, strategic planning, strategy, tactical plan (Blackstone, 2013).

Strategic planning is a part of **strategic management.** Strategic management involves the development and communication of the corporate

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 475–488
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goals, the strategic plans, the corporate philosophy, and the corporate culture (Hahn, 1991). It is the process of specifying the organization's mission, vision and objectives, developing policies and plans, often in terms of projects and programs, which are designed to achieve these objectives and then allocating resources to implement the policies and plans, projects and programs (Parnell, 2014).

While strategic planning is an important and necessary part of strategic management, strategic plans must be developed within the umbrella of corporate visions and missions. Strategic management also includes the implementation and evaluation of strategic plans; consequently, strategic plans must consider the outcomes, or actual results, when new strategic plans are prepared.

The basic functions of the corporate headquarters (HQ) in multibusiness firms are both entrepreneurial (value creation) and administrative (loss prevention). The three major types of management styles used at corporate headquarters are strategic planning, strategic control, and financial control. These styles, like the internal organization of the headquarters, result from different paths of growth and, therefore, from different patterns of investment and from different sets of organizational capabilities. These capabilities, in turn, reflect the different characteristics of the businesses in which the firms operate. An organization's success depends on how well it adapts those styles to their industries' characteristics. The budget's use as a mechanism of financial control is strong in financial control companies, moderate in strategic control companies, and weak in strategic planning companies (Chandler, 1991).

Carpenter offered the following distinctions between strategy and planning. "Strategy is concerned with the workings of a business and winning against one's competitors. The goal of business strategy is to secure an enduring competitive advantage that leads to a high ROI relative to the industry, as a whole. Planning, on the other hand, tends to focus on the development of specific, detailed programs for a product line, for facilities, for marketing, etc., that follow from the strategy" (Carpenter, 1986, p.51).

Objectives (Reasons for Adopting Program)

Businesses must first plan to survive, then to prosper (gain a competitive advantage, or avoid a competitive disadvantage). While the primary emphasis is on the financial well-being of the company—increased income and return on investment—it must also include the development and maintenance of its resources—employees, capital investments in plant and equipment, and its recognition as a positive contributor to society. Top management's job is to allocate resources to opportunities (Chandler, 1977).

While strategic planning is associated with corporate-level strategy development, the corporate plan must be a composite of the functional area plans and conversely, the functional level plans must conform to, and supplement, the corporate level objectives and strategies (Parnell, 2014). Functional areas include marketing, operations/manufacturing, accounting and finance, human resources and any other recognized function within a business. While all functions are important, the operations, or manufacturing, function must be a central part of most strategic plans.

Early writers in the strategy field highlighted the need to consider manufacturing as a key link in corporate strategic planning. Corporate strategies are generally developed to promote long-term competitive advantages for a firm. While the manufacturing function has been considered a major contributor to corporate success in manufacturing industries, little attention has been devoted to matching manufacturing strategy to the firm's overall corporate strategy. Strategy is usually developed first at the corporate level, then at the business-unit, and finally at the functional level, such as manufacturing. The manufacturing function should be given greater influence over the strategy setting process since it controls the firm's most costly resources. All manufacturing function decisions must be consistent with the particular competitive advantage sought by the firm, whether it is a cost, volume, or quality advantage. Manufacturing strategy will determine both the structure and capability of the manufacturing function. The strategy will encompass decisions about organizational hierarchy, vertical integration, and production control, as well as decisions about plant size and capacity, manufacturing technology, product quality, and labor relations (Wheelwright, 1984).

The strategic importance of manufacturing has received considerable attention over the last three decades. Firms have recognized the benefit of orienting this critical element of the value-adding process in a way that supported the overall strategy of the firm. Firms have moved well beyond the quality programs of the early 1980s to include manufacturing as part of an even larger strategic picture. A firm's manufacturing strategy is composed of a mix of management emphasis on cost, quality, delivery and flexibility. Together, these elements comprise what is known as the content of manufacturing strategy. If management truly wants to implement its manufacturing strategic plan, it must first make sure there is a common consensus among all groups over what is really important (McDermott, 1999).

History (Time Line, Reasons Originated, Principal Developers)

"The 1960s were characterized by long-range planning, a term for five-year forecasts and financial projections and objectives. During the late 1960s and early 1970s, the newly formed strategy consulting boutiques developed a whole series of subsequently over-generalized concepts that led planners and chief executives away from extrapolation and forecasts, towards issues of business economics and competitive interaction. That was the beginning of the strategic planning era" (Carpenter, 1986, p. 50).

Figure 13B.1 shows the total number of articles written about strategic management. Unlike many management programs, scholarly articles have been the dominant category of articles, representing over 70% of the articles published. The total number of articles peaked during the mid 1990s, dipped during the transition into the new millennium, and has continued to increase through 2012, with a slight decline in 2013.

Figure 13B.2 show the number of articles published using the keywords "strategic plan" or "strategic planning." The large number of articles shows a wide ranging interest, especially in trade journals. Figure 13B.2 only shows the activity beginning in 1975, although there were a few articles prior to that time.

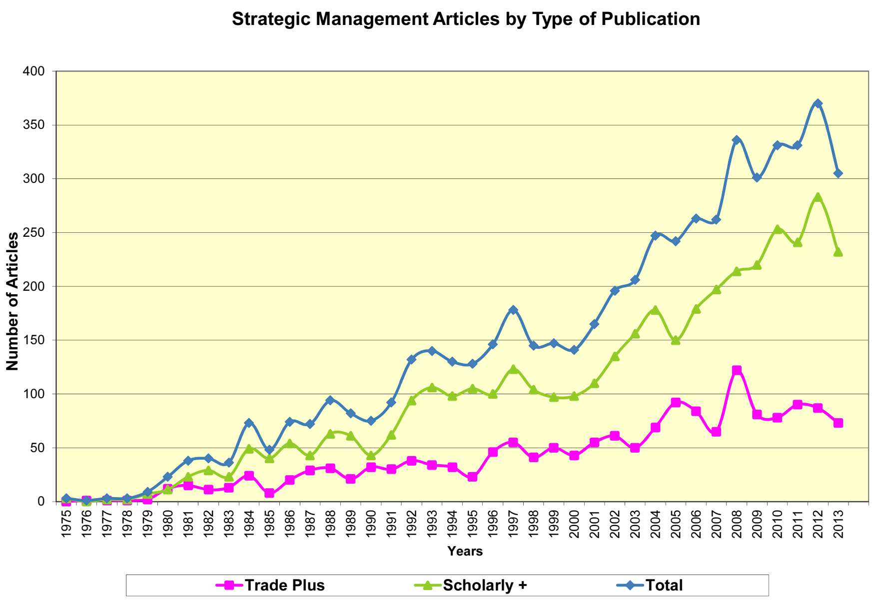

Figure 13B.1. Strategic management articles by type of publication.

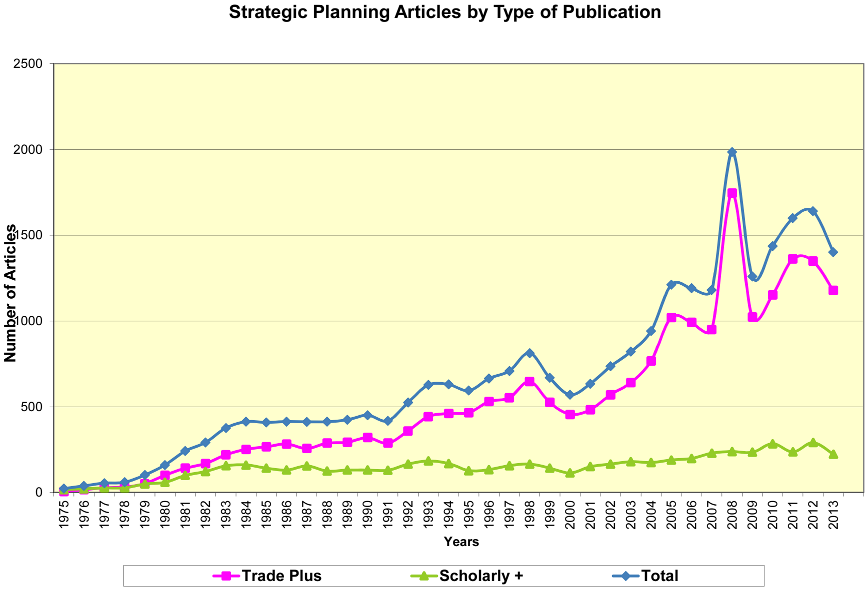

Figure 13B.2. Total number of strategic planning articles.

Figure 13B.3 shows the number of articles published with both "strategic management" and "strategic planning" used in the search. The small number of articles, when compared to when the key words were searched separately, suggest two possible explanations. First, there were two separate lines of thought in which one—strategic management—did not consider the other—strategic planning. Second, authors simply considered the two terms as interchangeable.

As shown in Figure 13B.3, over 70% of the total articles were in scholarly journals. This is the same as for the strategic management analysis in Figure 13B.1. Figure 13B.2, for strategic planning, shows that over 75% of the articles were from trade journals. Without further study, we cannot explain the differences; we can only point out that strategic management is considered to be separate, but closely related, to strategic planning.

Strategic planning has changed dramatically since its inception in the early 1970s. It has evolved into a viable system of strategic management (or strategic thinking). Among the more notable and important changes are a marked shift of planning responsibility from staff to line managers, decentralization of strategic planning to business units, and vastly increased attention to the changing market, competitive and technological environment. Planning systems have become more sophisticated in

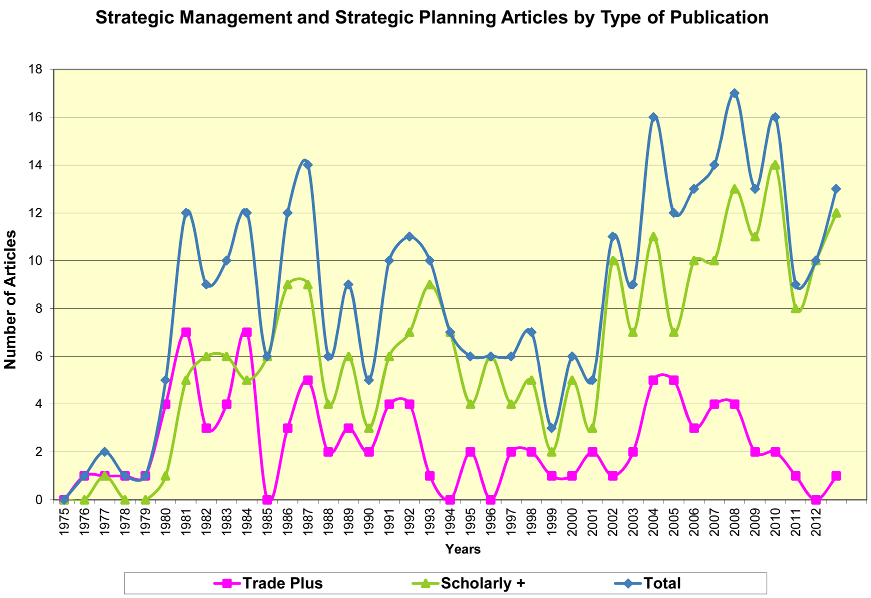

Figure 13B.3. Strategic planning and strategic management articles.

their selection of planning techniques. There is a greater willingness to use techniques (such as scenario planning) that are less mechanistic in their approach and more sensitive to the critical uncertainty of many of the variables that planning must address. In addition, there is a growing emphasis on organization and culture as critical ingredients in the execution of strategy (Wilson, 1994).

As strategic planning evolved, several writers posed key variations Mintzberg (1993) distinguished between planned, or what he termed deliberate strategies versus emergent strategies. While he agreed that some strategies could be developed in a formal planning process, he also observed that some strategies, often the most important strategies, occurred in a more spontaneous manner. He also stressed the need for strategic management, not just strategic planning.

Carpenter (1986), as Vice-President, Corporate Business Development and Planning at General Electric, pointed out, strategic planning had become too much of a formal process that stressed the process of planning instead of identifying the outcomes expected and the actions needed to achieve those outcomes. He agreed that strategy development is different from planning and the two should not be confused.

Expected Benefits (Tangible and Intangible)

The primary benefit expected of strategic management is that the organization will survive in the short-term, and prosper in the long-term. More specifically, strategic management implies the organization will select the right strategies to implement, will implement them effectively and efficiently, and will continue to adapt their strategies to meet changing conditions.

Results should be both tangible and intangible. Tangible results include financial well-being—profitability for businesses and ongoing financial stability for nonprofit organizations. Intangible results include acceptance as a positive contributor to the industry, the community and the welfare of the employees.

Barriers to Acceptance

This section lists a number of barriers to the successful implementation of strategic management and its key component, strategic planning. These barriers do not apply to all organizations or all situations; however, they offer a collection of thoughts over the decades. A portion of this section is adapted from Crandall and Crandall (2009).

Strategic planning is time-consuming. Preparation of strategic plans may involve the participation of a number of people from a range of functional departments. Development of goals and the strategies to meet those goals take time, often from managers who are also trying to run their departments at the same time. Abundance of data leads to an abundance of information. Unfortunately, a vast amount of uninterrupted information exists. As a result, organizations have a mix of data, information, knowledge and wisdom. Because of time constraints, it is sometimes more convenient to use whatever is in the most usable form even though it may not be the most relevant.

It is difficult to consider all possibilities. The intent of strategic management is to think "outside the box." This implies considering revolutionary threats and opportunities. Sometimes there are too many to thoughtfully consider. It is difficult to align the planning process within a single company and even more difficult to do it across multiple companies in a supply chain. There are too many options from which to choose. A byproduct of the information age is too many choices (Schwartz, 2004). For line managers, this requires analysis that is often time consuming. Consequently, operating managers too often accept the first feasible solutions since they are not able to search for the optimum solution. Herbert

Simon (1997) noticed this dilemma and coined the term satisficing, to indicate the best solution within the time constraints**.**

Tightly linked strategic and business plans may introduce rigidity into daily operations. Adhering to plans that are obviously not relevant is not only discouraging but may also be disastrous. Corporate planners must focus more on strategic thinking and less on planning, and the strategic planning process must be made more responsive (Carpenter, 1986). Some advocate contingency or scenario planning. However, this approach gives an air of indecisiveness that planners do not like. This type of planning allows for a range of possibilities, but often involves planning for crisis events. While good, this type of planning is not a substitute for comprehensive strategic planning.

It is difficult for small businesses to use formal methods. Larger organizations have full-time staff that can do much of the analysis and documentation of strategic plans; however, most small businesses depend on individual managers who must do the strategic planning at the same time they are managing their portion of the business.

The business environment is always changing. This observation is nothing new. Each generation of management theorists believe its generation was turbulent while the previous generation was stable (Mintzberg, 1993). This line of thinking began in the 1960s, when Drucker clearly elaborated it in his book *The Age of Discontinuity* (Drucker 1969). Plans are static but actual results are dynamic. Plans have a definite life span but the organization goes on in a continuous fashion. As a result, as the business environment changes, processes are needed to facilitate adjustments in the plans.

Management has an obsession with control. One of the symptoms of this obsession is the source of the planning goals. Often, line managers are told what their bottom line profits should be, and it is up to them to "figure out" how to meet that goal. In that case, input from line management is not setting the goals, but managing to reach the goals set for them. Another dilemma is lower level managers often have inadequate time to complete the planning process. The target completion date is often "set" by top management. Inevitably, the groups at the end of the process feel squeezed and may not have time to adequately link with the rest of the plans set by top management.

Coordination between departments is a problem. Upper level managers often set goals that lower level managers must attain. This situation creates a conflict between the upper and lower levels of the organization. Marketing managers have the goal of introducing new products with various features. Production managers must contain costs, usually with standard production runs that require a consistent product over time, in other words, as few new products as possible. Production and accounting managers often have conflicting goals in deciding inventory levels—production wants more, accounting wants less. Such differences can be resolved only when departments agree to exist as components of the system, not the system itself.

It is difficult to separate performance problems from environmental problems. Many organizations lack a mechanism for making changes in their plans. This lack of replanning capability may result in some confusion as to whether there is a performance problem, or an outside factor at work that is beyond the control of the line manager. Something as simple as bad weather can adversely cause a loss of sales and profits. In recent times, a worldwide economic downturn has negatively affected even the most efficient operations. Of course, if the problem is a performance issue, the situation must be addressed. In that case, adjustments to goals should reflect outside factors, not internal failures. Two questions emerge at this point: (1) how do you decide if actual conditions have changed enough to change the plan; and (2) at what point is it meaningless to continue to compare actual results with the plan? In light of the above discussion, companies need a realistic approach to strategic planning. This approach must adjust for changes that occur during the life of the plan.

Too many strategic plans are largely done by the planning department. Although the planning departments, or "planners," have an important role in preparing strategic plans, they should not make the critical decisions upon which plans rest. Planners should develop planning systems and provide input, but the line managers who have the responsibility to achieve the plan objectives should be the ones to make the final decisions.

There is a need for reality. At the risk of oversimplification, the root cause of strategic planning failures appears to be that the plans do not adequately reflect reality. Mintzberg (1993) distinguished between the intended strategy (plan) and the realized strategy (actual). He proposed that realized strategy resulted from a combination of intended strategy and emergent strategy—"patterns or consistencies realized despite, or in the absence of, intentions". Nonoka and Toyama (2007) present strategic management as distributed practical wisdom.

Implementation Approach

The following are basic steps for implementing strategic management in an organization.

Recognize the Need for Strategic Management

Although it may be obvious, top management must recognize the need to blend strategic management with the ongoing management of their organizations. Strategy has become a catchall term used to mean whatever one wants it to mean. But, strategists—whether they are CEOs of established firms or entrepreneurs—must have a strategy, an integrated, overarching concept of how the business will achieve its objectives (Hamrick, 2001).

To sustain successful development will require appropriate management concepts, in particular a further shift from strategic planning toward strategic management. The tasks and responsibilities of strategic management include:

- Determining the corporate philosophy
- Defining the corporate objectives and goals
- Formulating business, functional, and regional strategies
- Planning the company's organizational structure and its legal forms
- Planning the management system and process
- Implementing and supervising
- Designing the desired corporate culture.

Corporate philosophy and culture play a central role in ensuring a harmonious interplay between these different aspects of strategic management (Hahn, 1991).

Decide On an Approach

If a business must have a single, unified strategy, then it must necessarily have parts. A framework for strategy design should provide answers to five questions:

1. Arenas: where will we be active?
2. Vehicles: how will we get there?
3. Differentiators: how will we win in the marketplace?
4. Staging: what will be our speed and sequence of moves?
5. Economic logic: how will we obtain our returns? (Hamrick, 2001)

Match Resources to Actions (SWOT Analysis)

Strategic management extends beyond the realms of corporate planning and business policy to encompass the process of implementing strategies. The first stage in the process of strategic management involves the analyses of both internal and external factors affecting the company. The second stage is strategic choice, defining the project's mission and objectives. The implementation of plans is the final stage of strategic management (Morden, 1988).

Commit Human Resources

Recognizing the inevitable gaps between planning, implementation, and control, strategic management directs attention to the integration between planning and the actual implementation. The contingency approach analyzes the factors of implementation related to people and the organization. The development of winning cultures, characterized by the integration of purpose between the organization and its employees, depends on effective leadership. Ideally, strategic implementation involves an environment where people desire to achieve individual, corporate, and customer service excellence (Morden, 1988).

Develop Plans to Achieve the Strategies Selected

Business survival in a changing environment requires an effective strategic planning system geared to the management of change. Strategic planning aligns corporate goals and strategies, organizational structure, and human resource management with the corporate technical, political, and cultural systems requiring strategic management. Corporations must define their missions and strategies, determine who will influence mission and strategy decisions, and develop a supportive organizational culture. Organizational structure must be aligned with corporate strategies; power must be distributed and balanced across groups involved in strategy formulation and implementation; and a managerial style must be promoted to foster continuing cultural support. Finally, human resource management must match individuals to the organization's technical, political, and cultural systems through the proper distribution of rewards and career opportunities (Tichy, 1983).

Future

The faster rate of change makes planning more difficult; should management become more reactive? Should they even try to have a formal strategic planning process?

In today's business environment, companies are driven to conduct their core competencies in house and to obtain the rest from other sources through aggressive outsourcing. While outsourcing may seem attractive at the strategic management level, serious pitfalls are often encountered as the strategy is pushed downward into operations. At the operational level, the strategic intent tends to be lost in a hectic day-to-day, problem-to-problem business environment. Outsourcing decisions made at the operational level can easily lead to dependencies that create unforeseen strategic vulnerabilities (Insinga, 2000).

Strategic management must be closely aligned with project management. One study addressed two aspects of a topic under-researched in the strategic management literature: the alignment of project management and business strategy. Two areas of this alignment were studied: The reciprocal influence between project management and business strategy, which we call the nature of the project management/business strategy alignment; and the process used to align project management and business strategy (Milosevic, 2006).

There is a relationship between strategic management and knowledge management (Synman & Kruger, 2004). Effective strategic management requires distributed wisdom (which the philosopher Aristotle called "phronesis"). Strategy is created out of one's belief or commitment to a vision of the future, the ability to interpret one's environment and resources subjectively, and the interaction between subjectivity and objectivity. These abilities need to be distributed among organizational members. Strategy as distributed phronesis thus emerges from practice to pursue "common goodness" in each particular situation since a firm is an entity that pursues a universal ideal and a particular reality at the same time. Such idealistic pragmatism means that in a specific and dynamic context knowledge can be created and refined to become wisdom (Nonoka & Toyama, 2007).

Turbulence creates both the high risk of disaster and the opportunity for propulsion. The ability to navigate turbulence will be critical to leading companies in the new millennium. But today's questions cannot be answered with yesterday's textbooks. Macroeconomic indicators are uncoupling, their movements becoming entirely unpredictable (Rigby & Rogers, 2000).

"To increase the value-added of our profession, corporate planners must direct their activities towards strategic thinking and away from planning systems; towards vision and away from volume; towards insight and away from forms and formats; and towards creativity and away from control and bureaucracy" (Carpenter, 1986, p. 51).

Organizations are faced with the question of how to blend strategic planning and strategic management with other concepts such as: complexity and chaos theory, data analytics and cognitive learning by computers. While an obviously important management responsibility, strategic management remains an elusive program to successfully implement.

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CHAPTER 13C

KNOWLEDGE MANAGEMENT (KM)

NAME AND BRIEF DEFINITION

Knowledge management—Concept of information being used by executives, managers, and employees to more effectively produce product, interface with customers, and navigate through competitive markets (Blackstone, 2013).

Knowledge-based system—A computer program that employs knowledge of the structure of relations and reasoning rules to solve problems by generating new knowledge from the relationships about the subject (Blackstone, 2013).

Knowledge management tool—Provides an assortment of information quickly to stakeholders for faster and better decisions (Blackstone, 2013).

Information—Data that have been interpreted and that meet the need of one or more managers (Blackstone, 2013).

Additional definitions are available from Davenport and Prusak (1998) for data, information and knowledge, and the synonyms from the Microsoft Word Thesaurus for wisdom and clairvoyant.

- Data—a set of discrete, objective facts about events; in an organizational context, structured records of transactions.
- Information—a message, usually in the form of a document or an audible or visible communication. It has a sender and a receiver.

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Information is meant to change the way the receiver perceives something, to have an impact on his judgment and behavior. It must inform.

- Knowledge—broader, deeper, and richer than data or information. "Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in documents or respositories but also in organizational routines, processes, practices, and norms."
- Knowledge includes wisdom and insight.

The following are synonyms from Word Thesaurus:

- Wisdom—understanding, knowledge, insight, perception, astuteness, intelligence, acumen, good judgment, penetration
- Clairvoyant—intuitive, psychic, telepathic, second-sighted, perceptive, far-sighted

The definitions imply that value is added as data progresses to information and beyond to knowledge and wisdom. This progression will be explored more fully in a later section

Objectives (Reasons for Adopting Program)

Why is knowledge management and, as a corollary, the transfer of knowledge, important? Alvin Toffler, in his book, *Powershift* (1991) suggested that institutional power, for businesses and governments, had moved from military power to financial power and is in the transition to informational power. Other writers have also heralded the coming of the "information age" as a natural evolution as information technology (IT) continues to make greater contributions to management processes and job designs. As a result, IT is making it possible to generate more data and transform the data into meaningful information. This has increased the usability of information within businesses as integrated information systems, such as enterprise resource planning (ERP), have linked functions together. Comparable systems have also provided similar results in governmental and nonprofit agencies.

At the same time industry has been developing greater capabilities in information handling, other management strategies, most notably the movement toward decentralization, outsourcing, employee empowerment and supply chain integration, have made the transfer of knowledge imperative. It is impossible to manage a supplier in China from the United States without being able to transfer information in both directions quickly and efficiently. Knowledge sharing is important in everyday operations; it is essential in crisis situations.

Preserving knowledge continuity has emerged as a basic management priority and a fundamental responsibility of management. The goal of knowledge management is to get the right knowledge to the right person at the right time. Knowledge asset management includes knowledge transfer within the same employee generation, and knowledge transfer between employee generations. Continuity management addresses the vertical transfer of job-specific operational knowledge from incumbent to successor employees. Through continuity management, organizations can transform its business environment and build a competitive advantage. The preservation and application of corporate knowledge, competencies, and wisdom that continuity management promises is the most compelling reason for its implementation (Beazley, 2003).

Complementary knowledge transfer reflects the similarity of knowledge that the partners have and is conducted in pursuit of higher efficiency and productivity to enhance partner firms' existing competitiveness. Supplementary knowledge transfer occurs when partners each possess distinctive core competences and the information that is acquired or accessed increases the *business* scope of partners. As knowledge accession does not involve organizational learning, costs associated with the transfer process are lower and trust is easier to establish than in the case of knowledge acquisition (Buckley, et al. 2009).

The reuse of organizational practices in multiple locations is a fundamental way in which companies leverage knowledge to seek competitive advantage. Scholars argue that, to achieve fit with the local environment, some degree of adaptation is advisable, and the need for adaptation increases as the institutional distance between source and recipient locations increases. However, arguments to date have examined the effect of adaptation primarily on a subsidiary's long-term performance. A necessary precursor is to understand the effect of adaptation on the transfer process itself, as transfer difficulty, or stickiness, may preclude the reuse of an organizational practice in the first place (Jensen & Szulanski, 2004).

History (Time Line, Reasons Originated, Principal Developers)

For many years following the Industrial Revolution there was a period of stability where knowledge of processes could be assimilated at a slow

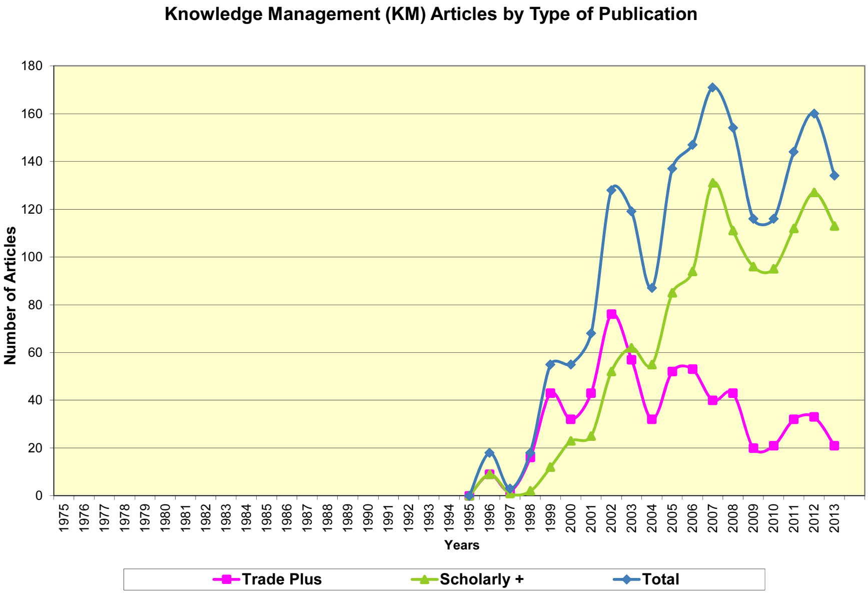


Figure 13C.1. Total number of knowledge management (KM) articles.

pace by new generations of workers. This is not so now, capital equipment is much larger and more expensive so it has to be kept working day and (often) at night. In other words, the pace of life has quickened, and knowledge management has become a real need. The acquisition of data has to be fast, and its exchange between workers has to be open to develop an awareness of interlinks between all the pertinent data. Peter Drucker (1957) was one of the first management writers to identify this as the need for the "knowledge worker." The world is not ideal; there are many factors that might inhibit *knowledge transfer*, thus delaying or denying learning. Further, each enterprise is but one member of a complex web of supply chains; therefore macro factors may inhibit multinational companies as they attempt to pursue their global *business* and exchange their knowledge (Kidd, 2003).

Figure 13C.1 shows the total number of articles written about knowledge transfer systems, classified by trade publications and scholarly publications. Beginning about 1995, the number of articles has increased steadily, equally divided between trade and scholarly articles. As supply chains become more important, the need to manage and transfer knowledge between partners becomes critical.

Expected Benefits (Tangible and Intangible)

The results also suggest an organization's adaptive capability concerning role and responsibility redistribution, development of new types of required knowledge and introduction of a different knowledge structure influence an organization's ability to convert standardized processes into business routines that provide a competitive advantage (Lee & Lee, 2000).

Effective infra-organizational KM suggests: (1) a need for the integration of these various models, concepts and perspectives to service the overall knowledge needs and interests of organizations; and (2) a holistic approach to KM that leverages the different human and technical aspects presently under consideration in many organizations. Since all of these concepts and models aim to increase the value of goods and services produced by organizations, a need exists to assess them using value creation measurement tools and techniques (Levergne & Earl, 2006).

Knowledge management technology may have already saved your life, or at least kept you from becoming very sick. Pharmacists and doctors use knowledge management to make sure certain prescriptions drugs are not taken together, lest the patient have a serious reaction, or even die. Hackensack University Medical Center uses such a system to make sure patients do not receive dangerous combinations of medication. The medical center also utilizes a robot to help doctors make rounds of their patients, while at home. The device, called Mr. Rounder can be operated from the doctor's laptop computer from home. Mr. Rounder can enter a hospital room and use a two-way video to talk to the patient about their condition. The robot even wears a white lab coat and stethoscope. Hackensack University Medical Center may be slightly ahead of the curve when it comes to using knowledge management techniques, and the results have been good. According to a recent *Business Week* article, patient mortality rates are down, while productivity and quality of care is up (Mullaney & Weintraub, 2005; Kreitner & Kinicki, 2007).

Knowledge is not limited to specific problems such as the investigation of employee turnover or the effect of supplier variances on customer service. It can be anything that is of value to someone in the business. It might be tips on how to better perform a task, or, it could be a series of workshops on how to prevent certain types of operational crises, such as machine failures or safety mishaps. Ernst & Young document best practices and then share them throughout their organization with a computer application called COIN (community of interest). Other companies actively involved in knowledge management include General Electric, Toyota, Hewlett-Packard, and Buckman Laboratories (Robbins & Coulter, 2007; Crandall, 2007).

Nonaka and Takeuchi (1995) explain the interactive process necessary for knowledge transfer is similar to how the ball moves spontaneously in a rugby match through intensive and laborious interaction among members of the team. They believe that "creating organizational knowledge is as much about bodily experience and trial and error as it is about mental modeling and learning from others. Similarly, it is as much about ideals as it is about ideas" (Crandall, 2007).

Barriers to Acceptance

While most would agree that acquiring and disseminating knowledge is important, knowledge transfer does not come easy. Some obstacles to knowledge transfer include:

1. **The organizational structure makes it harder to transfer knowledge.** Companies with rigid functional structures, that is, departments that may actually compete against each other, are at a disadvantage when it comes to sharing knowledge within the organization (Mohamed, Stankowsky & Murray, 2004). It should come as no surprise then, that flatter structures, virtual organizations, and companies that use cross-functional teams do a better job at knowledge management. Friesen (2005) echoes the idea that the network form of organization, which is flatter, will facilitate the flow of information.
2. **The right technology is not in place to share knowledge.** Moving knowledge throughout the organization should be a systematic process, not a random series of events. Achieving this involves a new culture of openness among management and staff. It also helps to use the right technology to move knowledge through the company. Intranets are good vehicles for doing this, especially in larger companies where employees are geographically separated from each other. There are also knowledge management software (KM software) programs that can aid in this process.
3. **The culture may not be receptive to knowledge transfer.** Some managers and executives fear sharing knowledge will erode their power base. Some fear sharing too much of their expertise may somehow compromise their power base. This mindset could actually be true in some businesses, especially those not committed to knowledge management. In fact, some consider the willingness to share, along with a supportive organizational culture, as the main factors needed for knowledge management to flourish (Lee, 2000). In one study, senior managers found it difficult to transform their

firms through programs of knowledge management because it takes a combination of technology, structure, and culture "along with a knowledge process architecture of acquisition, conversion, application, and protection" (Gold, Malhotra, & Segars, 2001).

These findings reinforce the notion that the successful transfer of best practices is highly dependent on the willingness of employees to share. More important, achieving knowledge transfer objectives is easier said than done. Trust and reputation develop over time, but are closely guarded by its representatives, and must be nurtured and protected. One study reinforces the need to create an appropriate environment for employees to engage in these activities. The findings reinforce the need to create an appropriate environment for employees to engage in activities, and the notion that knowledge management is critical to success, but its management requires specific approaches that do not apply to other resources (Lucas, 2005).

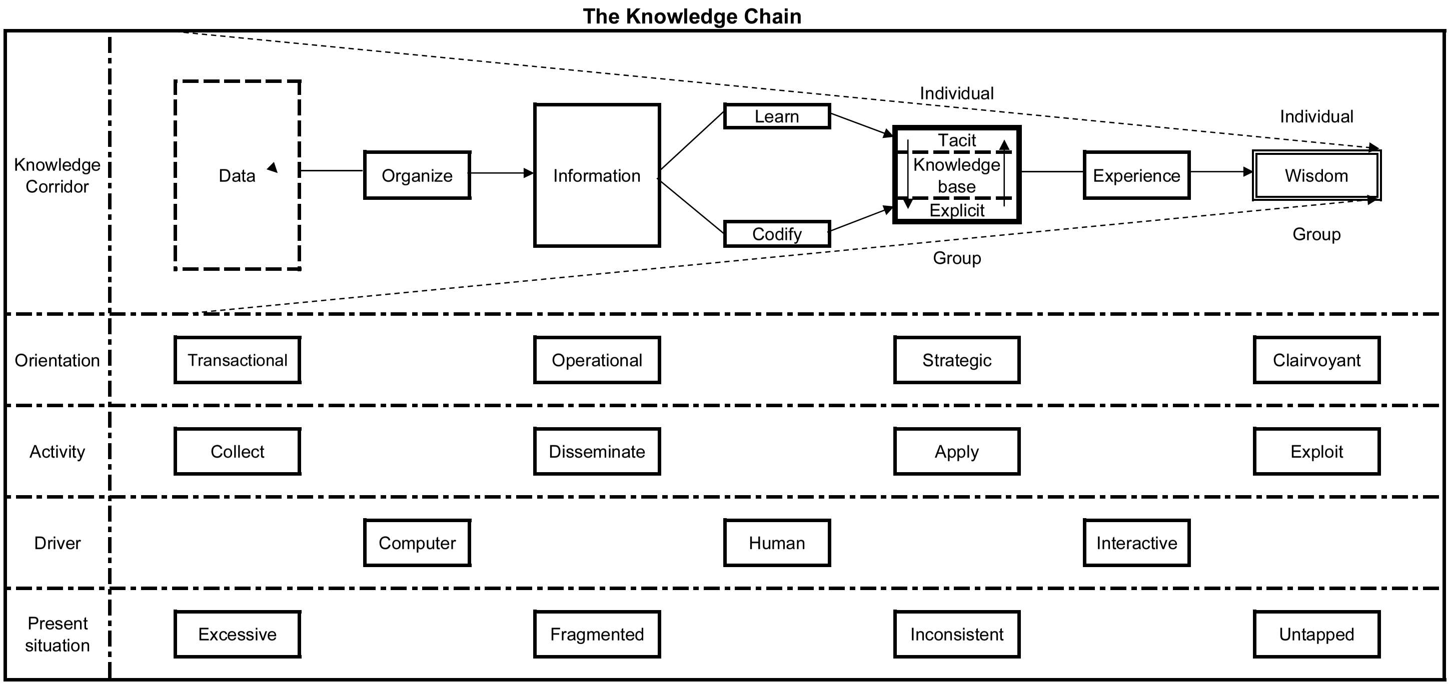
Implementation Approach

Figure 13C.2 shows a series of transformation processes moving from left to right. The progression is from the most basic (data) to the most sophisticated (wisdom).

From Data to Information

Data is transformed into information, largely by organizing bits of data into meaningful clusters of information. An example would be to take individual daily sales by item, by customer, and by store and summarize this into stock replenishment orders by item, buying trends by customer and revenue performance by store. Data is collected transaction by transaction and, in today's environment, by computers, such as point-of-sale terminals. Computers also do most of the data organizing activities. Information technology (IT) converts tasks from nonroutine to routine (Dibrell & Miller, 2002). At present, most organizations face the problem of having too much data that needs conversion to meaningful information.

Most organizations are still learning to effectively use their information to make routine decisions in areas such as inventory management, customer relationship management (CRM), and resource utilization. To do this, they need an effective system for disseminating the right information to the right people to make the right decisions. They want to send enough information to users so they can make better decisions; however, they do not want to overburden users with excess information. It is a complex and continuous process to affect an effective flow from the data col-



Source: Crandall and Crandall (2014, p. 474).

Figure 13C.2. The knowledge corridor.

lection point to the decision-making point. Today, the effectiveness of information systems ranges from leader companies with smooth and comprehensive flows to laggard companies who have undirected data collection and erratic information flow.

Figure 13C.2 shows converging lines that move from a widely separated state at the data stage of the knowledge chain to more narrowly separated states on the right-hand side of the diagram. This illustrates the need for a selection process that separates and preserves the most important data into more concise elements of information.

From Information to Knowledge

The next major transformation process converts information into knowledge. While converting data to information can be handled largely by computers, most authorities agree it takes people to convert information to knowledge. This conversion has two major paths—learning and codifying. Learning is a process in which individuals convert information to tacit knowledge, or knowledge lodged within their own minds. Several sources describe this learning process including Fahey and Prusak (1998), Girard (2006), and Lester and Parnell (2007). Tacit knowledge remains with an individual until they share it with another individual or codify it to make it available to groups. From an organization's perspective, tacit knowledge is only valuable as long as that individual stays with the organization. It is to the organization's benefit to convert tacit knowledge to explicit knowledge.

Codifying information involves documenting in some formal process the rules, policies, and procedures of an organization into explicit knowledge. Explicit knowledge is often the result of a group effort and is available to a wide cross-section of the organization. It extends beyond the tenure of any individual or groups of individuals; it is part of the organization's knowledge base.

Companies use knowledge for strategic planning and making decisions. Today, it appears there is greater disparity among organizations in using knowledge than there is in using information. Information comes from systems that are being standardized to facilitate intercompany communications. Knowledge, however, comes largely from individuals and there is great variation among people. Companies are often willing to share information; they are less willing to share knowledge. As with the movement from data to information, Figure 13C.1 extends the converging lines to convey the concept that knowledge is extracted from information into more concentrated and focused resources.

From Knowledge to Wisdom

The final stage shown in Figure 13C.2 is the transformation of knowledge into wisdom. Davenport and Prusak (1998), in their excellent book, *Working Knowledge, How Organizations Manage What They Know*, combine wisdom, or insight, into a broader category of knowledge. However, some believe that wisdom warrants a separate category because of its tremendous potential for companies. This is unexplored territory for most companies and for individuals within those companies. Wisdom implies a level of understanding beyond that shown for knowledge. Wisdom is largely unique to individuals. It is hard to conceive of wisdom as coming from an inanimate organization. Individuals gain wisdom in a variety of ways but largely through their own experiences. Some individuals gain wisdom while others, with similar experiences, do not. The expression, "Twenty years of experience" versus "one year of experience twenty times" seems to capture this distinction. One of the anomalies is that some people have it but many do not. Individuals with wisdom may have an uncanny knack of predicting outcomes or spotting problems or opportunities before others do. They may appear clairvoyant, or having a form of second sight, a characteristic that would be a desirable capability for businesses to have in the future. When an organization discovers wisdom in an individual, they should exploit it for the good of both the organization and the individual.

Gaining wisdom is a learning process; exactly how that process works is still largely unknown. In fact, some individuals may have wisdom but are not aware of it because it is difficult to recognize and document. As a result, wisdom is an untapped resource in most organizations because it takes a rare combination of circumstances and individuals to expose wisdom. The converging lines in Figure 13C.2 continue to narrow as the diagram reaches wisdom (Crandall, 2007).

Moving along the knowledge corridor requires learning, both by individuals and by organizations. Lytras and Pouloudi (2006) point out the need for integrating knowledge management and learning activities, which they feel have been under-represented in most companies, and illustrate how the two can be jointly supported by various knowledge management systems.

Learning is a topic that warrants more space than we have available in this section. One of the classic books on this subject is Peter Senge's *The Fifth Discipline, The Art & Practice of the Learning Organization*. He calls systems thinking (a discipline for seeing patterns of change) the fifth discipline because it underlies all of his learning disciplines of personal mastery, mental models, shared vision, and team learning (Senge, 1990).

Baird and Griffin (2006) point out that rapid change is driving the need to develop learning systems. The first requirement of learning in a computer-pervasive, networked world is speed of learning. The second requirement is to integrate learning across cross-functional units and the third requirements is to facilitate learning in real time. A dynamic learning process consists of (1) learning **for** performance; (2) learning **during** performance; and (3) learning **from** performance. If an organization knows what is to be learned, they can "transfer" existing knowledge before performance, "prompt" learners during performance, and "evaluate" the results after the performance. If an organization does not know what people need to learn, they "focus" on providing basic knowledge before performance, stress "capture" of information during performance, and "interpret" (synthesize, digest) what was learned after performance.

Daniel Pink has written one of the current best sellers, *A Whole New Mind, Moving from the Information Age to the Conceptual Age* (2005). He believes that the rational, logical linear thinking that carried business to its present level is inadequate for the complexity and increasingly competitive business world of tomorrow. Instead, as he puts it, "The future now belongs to a very different kind of person with a very different kind of mind. The era of 'left-brain' dominance—and the Information Age that it engendered—is giving way to a whole new world in which artistic and holistic 'right-brain' abilities mark the fault line between who gets ahead and who falls behind" (Crandall, 2007).

Future

Will knowledge, or the management of knowledge, ever replace things such as products or services? Perhaps not, at least in the immediate future. However, the question raises some interesting possibilities because the availability of knowledge could reduce the need for some goods or services. Let's consider two situations. Suppose the knowledge, or experience, of visiting a tourist attraction, such as the Grand Canyon, is packaged into a virtual reality presentation that could be viewed (experienced) in the comfort of your home. Would that not reduce the need to travel to that attraction, with the incumbent burden of driving a car or flying in an airplane and all of the services required along the way (McConnon, 2007)? The second situation. Suppose that all of the knowledge required to qualify for a degree from a university were packaged and available for individuals to access at their convenience and ability to absorb. Would that not reduce the need for facilities—campus and buildings—and complementary services—faculty and staff—now required? Lest you write these off as fantasies, the technology to achieve both of these situations is being developed; it only remains to sell the ideas to the consumer and, probably more difficult, to the present providers (Crandall, 2007).

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CHAPTER 13D

RISK MANAGEMENT

NAME AND BRIEF DEFINITION

> In the context of supply chain management, risk management involves dealing with uncertainty in supply, transformation, delivery, and customer demand. The uncertainties can be the result of such factors as yields, timing, pricing, and catastrophic events. Risk management starts with a realistic analysis of the risks and results in a strategy that minimizes the financial impact of these uncertainties. These strategies may involve dual sourcing, buffering, forward buying, and other tactics. Contingency and recovery planning may be an important part of the strategy, particularly when risk probabilities are very low. (APICS, 2009)

The following definitions relative to risk management are from the APICS Dictionary

Risk management planning—The process of defining how to identify and minimize risk factors for a project (Blackstone, 2013).

Risk response plan—A document defining known risks including description, cause, likelihood, costs, and proposed responses. It also identifies current status on each risk (Blackstone, 2013).

Risk response planning—The process of developing a plan to avoid risks and to mitigate the effect of those that cannot be avoided (Blackstone, 2013).

Risk mitigation—Reducing the exposure to risk, wither by its likelihood or its impact (Blackstone, 2013).

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Business Continuity Planning (BCP)—a logical/methodical approach to remaining in control of the environmental issues you can control. In terms of business requirements it relates to establishing the right processes, procedures and resources necessary to continue in business in an acceptable form when "something" interrupts that business (Devargas, 1999).

As companies move toward integrated supply chains, they increase the risk of disruptions in the flow of goods and services to their customers.

Objectives (Reasons for Adopting Program)

The primary objective of a risk management program is to identify potential risks and design a program to prevent or mitigate the unfavorable consequences should the risk become a reality.

Supply managers must manage many risks in their increasingly competitive environments. Traditionally this meant buffering against uncertainties, which could reduce the effectiveness of operational performance. Risk management can be a more effective approach to deal with these uncertainties by identifying potential losses. Situational factors, such as the degree of product technology, security needs, the relative importance of the supplier, and the purchasers' prior experience with the situation should be taken into consideration when determining the level of risk management in the supply chain. Doing so can avoid unforeseen losses and lead to better anticipation of risks (Giunipero & Eltantawy, 2004).

Supply chains are becoming increasingly global as they increase their outsourcing programs; at the same time, companies continue to adopt technologies and processes that will lead to leaner operations. Consequently, these developments are forcing companies to more closely assess the risks and interdependencies in their supply chains. What can managers do to prevent, or mitigate, the growing supply chain risk? The answer lies in the creation of a risk management program that assesses potential risk and then develops strategies to manage that risk. The process begins with developing a better understanding of your supply chain—both downstream toward your customer and upstream toward your suppliers. In addition to mapping and assessment tools, other solutions are available to help manage supply chain risk. Some leading companies are using network-design tools in innovative ways such as modeling the networks of their key competitors to test various scenarios and to perform frequent what-if analysis (Hillman, 2006).

Risk management in the supply chain is not the same as disaster response. Rather, it means keeping an increasingly complex process moving effectively and efficiently at the lowest total cost and without compromising the quality of the product or customer satisfaction. In assessing the viability of a supply chain, companies often undervalue the presence of risk as well as the complexity of risk. A company should adopt a strategy that analyzes supply chain risk and, from this analysis, make sound business decisions. It is called risk-adjusted supply chain management. Risk-adjusted supply chain management can help an organization identify, quantify, and prioritize the risks inherent in its supply chain. Paying more attention to risk is critical as new technologies, regulatory requirements, consumer demands, and potential disruptions combine to make supply chain management increasingly complex (Hauser, 2003).

There are at least four levels of disruptions, ranging from minor to major.

- **Variability**—This is the normal variation in supply chain flows. It is predictable within established limits, controllable with normal practices, and does not present a serious threat to the welfare of the company. Example: the fluctuations in the arrival time of a truck delivery at the retail store from the distribution center.
- **Uncertainty**—This condition has wider variation that is sometimes unpredictable, although usually not unknown. It takes preventive or corrective action, and the company is vulnerable if actions are not taken to avoid or quickly resolve the uncertainty. Example: the arrival time of the first shipment from a new supplier.
- **Risk—**The event may be identifiable in advance but the timing and magnitude of an occurrence is uncertain. An occurrence can cause significant disruption in supply chain flows, and requires pre-planned responses to avoid serious consequences. Example: the arrival time of a ship from a new offshore supplier at a port with severe unloading capacity constraints.
- **Crisis**—This is a low probability but high impact occurrence, often unpredictable or unexpected (Crandall, Parnell, & Spillan, 2014). It requires prompt and exceptional skills to handle. The responses may be planned but often require extemporaneous adaptation to resolve the situation. A crisis can be fatal to the company if not managed properly. Example: the discovery of lead contamination in toys that caused the death of a child (Crandall, 2010).

Disruptions from variability and uncertainty can usually be handled through normal business practices, although their resolution or prevention may introduce higher costs. Disruptions from risks and crises offer the greatest challenge for managers.

Many supply chain risks can be identified ahead of time through careful analysis. Once identified, plans can be prepared to mitigate the effects of these risks, if actually incurred. However, if not identified or mitigated, risks can turn into crises. In addition, a crisis can arise from a natural disaster, such as a flood or fire that can be completely unexpected or unplanned for. Business Continuity Management gives companies the ability to minimize the effects of a severe supply chain disruption (Hartman & Sullivan, 2007).

Business Continuity Planning (BCP) is a business process that is designed to assure the continued operation of an organization in the face of any form of crisis or disaster. It is the responsibility of all levels of an organization and, in today's business environment, all companies should have a fully tested and integrated BCP in place. In today's changing business world, companies are being continually exposed to a constant stream of threats and potential risks that could undermine a business at any time if not identified and addressed. These include not only the already recognized, familiar threats, such as fire and technical failures, but also the emerging threats such as cyber crime, virus attacks, terrorism, and the increased likelihood and consequences of supply chain disruption and financial failure. With the increased scope of emerging risks, companies must now re-focus on understanding their vulnerabilities, increase their awareness and take decisive action based on accurate information and informed judgment to address these issues (Dawes, 2004).

BCP provides the guidance required during a crisis and ensures that vital issues are not overlooked. A business impact analysis involves identifying the critical business functions within the organization, determining the impact of not performing the business function and ascertaining the cost implications. Staff personnel should be informed of their responsibility to maintaining a safe and secure environment and how to react in the event of a disaster (Devargas, 1999).

BCPs, once the narrow focus of risk managers and continuity practitioners, are on the front pages of the business press and on the minds of the world. September 11 brought BCP successes and failures; by analyzing what went wrong, companies can help prevent history from repeating itself. Eight Points of BCP failure include: (1) a one-size-fits-all solution; (2) deficiencies in the tests; (3) inadequate maintenance; (4) lack of senior management involvement; (5) no enterprisewide accountability and coordination; (6) operations taking a backseat to technology; (7) no clear leadership structure or management contingency plans; and (8) rash cost-reduction campaigns that eliminate the BCP (Grimaldi, 2002).

History (Time Line, Reasons Originated, Principal Developers)

Today's business environment is filled with turbulence and uncertainty. Market turbulence has increased for a number of reasons, while the vulnerability of supply chains to disturbance or disruption has increased. It is not only the effect of external events such as wars, strikes or terrorist attacks, but also the impact of changes in business strategy. Many companies have experienced increased risks in their supply chain as a result of the adoption of "lean" practices, the move to outsourcing and a general tendency to reduce the size of the supplier base (Christopher & Lee, 2004).

Figure 13D.1 shows the total number of articles written about risk management. Beginning in the 1970s, the number increased steadily for over 20 years, and accelerated rapidly after 2000, most likely as a result of the 9/11 terrorist attacks.

The breadth and scope of supply chain risks have broadened significantly in recent years. Even prior to the 2001 terrorist attacks, the presence of risks and uncertainties were widening with increased globalization, widening political reach by leading countries, and the rise of market producing and consuming economies (Barry, 2004).

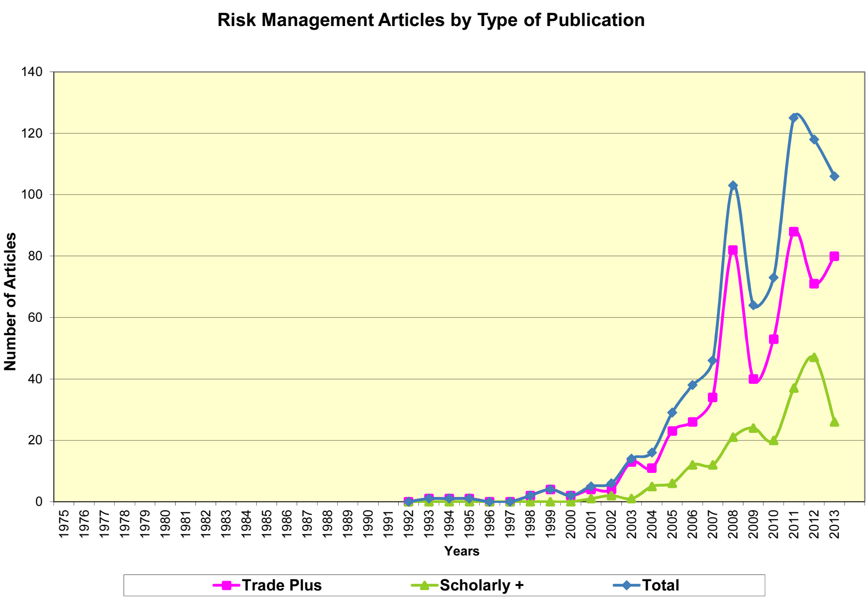

Figure 13D.1. Total number of risk management articles.

Why is risk management in the supply chain so important now? The creation of global supply chains has brought new risks that you may not have encountered before. The simple fact is that in today's longer, more global supply chains, products move over greater distances and across more borders than in the more localized supply chains of the past. The coordination and execution required for international shipments has always been a challenge. Market conditions, security considerations, and regulatory pressures are converging in such a way that makes the task even more daunting (Crone, 2006).

Expected Benefits (Tangible and Intangible)

Many companies leave risk management and business continuity to security professionals, business continuity planners or insurance professionals. However, building a resilient enterprise should be a strategic initiative that changes the way a company operates and increases its competitiveness. Reducing vulnerability means both reducing the likelihood of a disruption and increasing resilience. Resilience, in turn, can be achieved by either creating redundancy and/or increasing flexibility. Redundancy involves keeping some resources in reserve to be used in case of a disruption. The most common forms of redundancy are inventory safety stock, the deliberate use of multiple suppliers even when the secondary suppliers have higher costs, and operating with low capacity utilization rates. Although necessary to some degree, redundancy represents pure cost with no return except in the event of a disruption. More leverage and operational advantages can be achieved by making supply chains flexible. Flexibility requires building in capabilities that can sense threats and respond to them quickly (Sheffi & Rice, 2005).

Some of the more tangible benefits include:

- Identifying potential disruptions and taking action to prevent them
- Identifying potential disruptions that could become a crisis and designing prevention or recovery programs
- Improving normal operations to reduce the potential for disruptions
- Improving forecasting (Richardson, 2006)

A number of studies have identified potential sources of supply chain disruptions:

- New suppliers (Nagali et al., 2008 about procurement uncertainty; Stokes, 2008)
- Outsourcing (Fitzgerald, 2005; Tate & Ellram, 2009)
- Process improvements (Lazere, 1997 about lean)
- IT system failures (Crandall, Parnell, & Spillan, 2014)
- Customer injury, food poisoning (Gessner, Volvnino, & Fish, 2007 about food; Johnson, 2001 about toys; Kumar & Budin, 2006 about food; Reece 2007 about hazardous chemicals)
- Problems in funds flow (Giarraputo, 2008).
- Changes in marketing programs, approach to customers, e-business (Hunter et al., 2004)
- Natural disasters—floods, earthquakes, (Kleindorfer & Saad, 2005)
- Energy crisis—oil (La Londe, 2006; Mills, 2001 about California power)
- Supply chain complexity (Lutze, 2004 dissertation; Manuj, 2008 about globalization; Ritchie & Brindley, 2002 about global supply chains)
- New ventures (MacMillan, Siegel, & Narasimha, 1985)

Business Continuity Management gives companies the ability to minimize the adverse effects of a severe supply chain disruption. Well-developed business continuity planning concentrates on logistics, enabling supply sources to overcome the threat of severe disruptions. These plans also require a new understanding of crisis management, employee support, and collaboration and communications to support management in a large-scale supply chain disruption. Supply chain disruptions can be mitigated via the new capabilities of the collaboration and communications platform. During a crisis, a number of conditions occur that affect supply chains. These include disruption of telecommunications capabilities, dislocation of critical people, cessation of transportation and limited access to critical resources and facilities. Leading companies are now deploying new Internet-based capabilities, such as digital swarming, presence-based collaboration, distributed intelligence and asset management as part of the BCP (Hartman & Sullivan, 2007).

Ericsson, after a fire at a sub-supplier, implemented a new organization, and new processes and tools for SCRM. The approach analyzed, assessed and managed risks along the supply chain, partly by working closely with suppliers but also by placing formal requirements on them. Insurance companies may be a driving force for improved SCRM, as they now start to understand the vulnerability of modern supply chains. In addition to the traditional logistics concepts (time, cost, quality, agility and leanness), supply chain risks should also be put into the trade-off analysis when evaluating new logistics solutions—not with the purpose to minimize risks, however, but to find the efficient level of risk and prevention (Norrman & Jansson, 2004).

Barriers to Acceptance

Implementing risk management or business continuity programs involve a number of obstacles, including:

- Difficulty in identify all of the potential disruptions
- Time consuming preparation of contingency plans for all potential disruptions
- Employee resistance to change (culture)
- Difficulty in measuring risk potential because of accounting systems (Eiler & Cucuzza, 2002)
- Difficulty in reporting risk potential to outside investors (Epstein & Buhovac, 2006)

Outsourcing business processes and information technology (IT) functions to entities overseas may appear to cut costs and maximize profitability; however, it can also cause significant risks if it is not managed effectively. In fact, outsourcing may ultimately increase, rather than decrease, the total risk for your organization. Enterprise risk management (ERM) analysis of outsourcing is so important because more companies are outsourcing a greater number of functions than ever before. With growing frequency, outsourcing decisions are spurred by opportunities to capture huge labor cost savings by shifting core business processes to highly capable overseas providers whose labor rates are dramatically lower than comparable ones in the United States (Beasley, 2004).

Implementation Approach

There are several strategies for managing supply chain disruptions: (1) improve processes to reduce variation in supply chains; (2) buffer against unexpected disruptions; (3) manage through the disruption to minimize the adverse effects; (4) when unexpected disruptions occur, develop a recovery plan to mitigate its effects; and (5) insure against the expected losses.

Reduce Variation in the Supply Chain

One of the most desirable alternatives is to improve the processes within and between supply chain participants to reduce the variability in performance, thereby reducing the risk of disruption. This requires a high level of collaboration and trust among participants. Companies are beginning to build on collaborative relationships to develop programs focused on supply chain resiliency, risk identification and continuity planning (Hartman & Sullivan, 2007). Successful companies break the risk spiral by restoring confidence throughout the supply chain (Christopher & Lee, 2004). A study of the food supply chain recommends improving information visibility through the use of electronic records management (ERM) to facilitate traceability, especially in time of crisis (Gessner, Volonino, & Fish, 2007). Another study of the food industry encourages the use of radio frequency identification (RFID) and warehouse management systems (WMS) to improve supply chain integrity and traceability (Kumar & Budin, 2006).

Introduce Buffers to Absorb Disruptions

Another approach is to design buffers in the supply chain to absorb the fluctuations in flows. Companies may use extra inventory as a buffer against late deliveries, or extra capacity as a buffer against unexpected demand. The company incurs some additional carrying cost, but avoids even greater expenses if the disruption occurs. Companies need flexibility to handle the fluctuations in demand and supply they may encounter.

Manage Through the Disruption

In some cases, management may decide buffering against all possible risks is impractical, or even impossible. They accept the inevitability of a disruption, but devise a plan to manage the disruption in order to minimize the adverse effects. They may have alternate suppliers available, or a plan to allocate available products and capacity among their customers.

Develop a Recovery Plan

Where disruptions are significant, the company should have a recovery plan to put into action after the disruption. If their main location is damaged beyond use, they may have a “hot site” (a reserve location that can be activated in case of emergency) available to put into operation if needed (Crandall, Parnell, & Spillan, 2009). In a crisis, they can use a crisis management team (CMT) to communicate with other members of the supply chain. If needed, such as in the case of fire or flood with potential loss of life, the CMT can also handle communications with the local government agencies and the public.

A number of companies are preparing to meet an increasing variety of risks in their supply chains. KPMG (2009) recommends the addition of a Risk Executive at the C-level of the organization to assure there is adequate representation in this area. While there are a number of possible approaches, each company must design one that best fits its situation.

Insure Against Losses

In some cases, companies can buy insurance to recover losses from disruptions. However, the higher the potential loss, the higher the cost of insurance and risk managers must weigh the trade-offs. In some cases, insurers are looking more closely at the strategies used by companies. In commenting on the trend toward JIT, or lean manufacturing, one writer points out an insurer should recognize the potential downfalls that could "mean the difference between writing a profitable account and taking a potentially hard hit to the bottom line" (McGillivray, 2000).

Participation of Employees and Managers

Disruptions in the supply chain can rarely be resolved by computers or automated equipment; it takes human intervention. While employees at all levels may be involved, the more serious the disruption, the higher the level of management required to mitigate its effects. In a crisis, often the CEO must become the spokesperson for the company to coordinate the resolution and recovery from the crisis and to communicate quickly and clearly the progress taking place (Crandall, Parnell, & Spillan, 2014).

In many risk and crisis situations, additional members of the supply chain may be needed to help resolve the situation. This places more importance on building the kind of collaborative and trust-building relationships that will help bring the situation to a satisfactory conclusion.

Risk and Crisis by Industry

Supply chains in some industries are receiving increased public scrutiny because of their importance to the safety and welfare of the country and its citizens. The supply chains for the military are an obvious focal point because of the need for smooth flow of the right kind of equipment to troops in combat situations, often in remote locations not designed for a smooth flow of goods.

The oil industry faces fluctuations in both supply and demand, whether it be in the form of hurricanes in the Gulf of Mexico or economic downturns worldwide. The industry must gauge the seasonal changeovers from summer vacation travel to winter heating. While price adjustments may reduce the effect on company income, they do little to satisfy consumers.

Food supply chains are becoming high profile targets, especially when there are outbreaks of E-coli illness and deaths in supply chains that have difficulty identifying the source of the problem (Gessner, Volonino, & Fish, 2007). Traceability is an important requirement in food supply chains and the government will likely increase its requirements in this area because of the potential threat to human life.

The pharmaceutical industry must also work to manage the risks in their supply chains. The current concern over the limited availability of flu vaccines, both regular and H1N1, is causing concern among public officials and the citizenry. The presence of websites and blogs suggesting possible contamination or risks in using the vaccine is adding to the likelihood of disruptions (Crandall, 2010).

Terrorist attacks, natural disasters, and regional power outages over the past several years have all highlighted the low levels of disaster preparedness that exist at many firms. Supply chain disruptions caused by external events can have a significant financial and operational impact on firms not properly prepared. One critical component of disaster management planning in supply chains is the storage of emergency supplies, equipment, and vital documents that will be needed in times of crisis (Hale & Moberg, 2005).

Future

Risk management is an enterprise-wide process involving representatives from senior management as well as functional participants from finance, operations, internal audit, and risk management (Hauser, 2003). As one writer puts it, "For better or worse, in this age of lean, expended and outsourced operations, 'disaster-proofing' your supply chain isn't an option, it's an obligation" (Reese, 2007, p.42). Researchers from the Massachusetts Institute of Technology (MIT) warn many companies not to leave risk management to security professionals, business continuity planners and insurance professionals when they should be building a resilient enterprise to cope with potential disruptions (Sheffi & Rice, 2005). Recent incidents such as defective Chinese drywall have forced many companies to learn the hard way their suppliers' issues are also their own (Stokes, 2008).

Supply chain disruptions are an area of increasing concern for business managers. Some disruptions can be prevented through improvement processes. Some can be mitigated through careful management. Some can be endured if the company is strong enough. However, if the crisis is severe enough, the company may be forced out of business. Hopefully, companies can prevent a crack from becoming a sinkhole (Crandall, 2010).

Businesses must measure risks, try to minimize them and—if possible—use them to their advantage. The CPA is the professional well suited to help manage risk. CPAs—as internal or external advisers—have the skills and competencies required to help companies evaluate and address risk (Bodine, Pugliese, & Walker, 2001).

Natural disasters, labor disputes, terrorism and more mundane risks can seriously disrupt or delay the flow of material, information and cash through an organization's supply chain. How well a company fares against such threats depends on its level of preparedness, and the type of disruption. Each supply-chain risk—to forecasts, information systems, intellectual property, procurement, inventory and capacity—has its own drivers and effective mitigation strategies. To avoid lost sales, increased costs, or both, managers must tailor proven risk-reduction strategies to their organizations. Armed with shared understanding, companies can then select the best mitigation strategy: holding "reserves," pooling inventory, using redundant suppliers, balancing capacity and inventory, implementing robust backup and recovery systems, adjusting pricing and incentives, bringing or keeping production in-house, and using Continuous Replenishment Programs, Collaborative Planning, Forecasting and Replenishment and other supply-chain initiatives (Chopra, 2004).

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CHAPTER 13E

VIRTUAL MANAGEMENT OR VIRTUAL ORGANIZATION

NAME AND BRIEF DEFINITION

Virtual corporation—The logical extension of outpartnering. With the virtual corporation, the capabilities and systems of the firm are merged with those of the suppliers, resulting in a new type of corporation where the boundaries between the suppliers' systems and those of the firm seem to disappear. The virtual corporation is dynamic in that the relationships and structures formed change according to the changing needs of the customer (Blackstone, 2013).

Virtual organization—Short-term alliances between independent organizations in a potentially long-term relationship to design, produce, and distribute a product. Organizations cooperate based on mutual values and act as a single entity to third parties (Blackstone, 2013).

Based on the above definitions, a virtual organization can include outsourcing arrangements and supply chains with multiple members. Any supply chain (or network) connected through electronic links can be considered virtual. However, a virtual supply chain often encompasses much more than electronic links. It represents an organization structure that facilitates efficient and effective flows of both physical goods and information in a seamless fashion. What distinguishes the virtual chain from the traditional supply chain is its inherent flexibility to quickly adopt and adapt to changes in the business environment. As a result, new members

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can be continually added and old members deleted or have roles reassigned to them within the chain. Consequently, the ability to reconfigure organizational structures provides the chain the capability to customize solutions for different segments of customers or keep up with changes in customer requirements. This adaptability of the chain is likely to lead to competition between chains rather than between organizations (Chandrasekar & Schary, 1999).

Another study suggests that interorganizational virtual organizations are independent, temporary network organizations, that are based on swift trust. They make it possible for small to medium enterprises to exploit market opportunities, and enable member organizations to create a value-adding partnership. Information and communication technology (ICT) is the essential enabler of virtual organizations. Finally, interorganizational virtual organizations act as a single organizational unit and therefore constitute a uniquely distinguishable organizational form. Related research areas include trust, organizational behavior, transaction economics, virtual human resource management, and business strategy (Kasper-Fuehrer & Ashkanasy, 2003).

The characteristics of the emerging virtual organizations are significantly different from those found in traditional, hierarchical companies. Virtual organizations seem to have five overarching characteristics in common:

- They have a shared vision and goal or a common protocol of cooperation.
- They cluster activities around their core competencies.
- They work jointly in teams of core-competence groups to implement their activities in one holistic approach throughout the value chain.
- They process and distribute information in real time throughout the entire network, which allows them to make decisions and coordinate actions quickly.
- They tend to delegate from the bottom up whenever economies of scale can be achieved, new conditions arise, or a specific competence is required for serving the needs of the whole group (Voss, 1996).

The description by Voss implies that, for supply chains to reach a virtual state, they must move from a loosely-coupled structure to a tightly-coupled unit.

Objectives (Reasons for Adopting Program)

The primary objective of virtual organizations is to provide added value for customers. This added value requires more than any single company can provide; therefore, there is the need for value chains. A current trend in the world of business enterprise is the convergence of concepts and guiding principles such as Total Customer Experience, Network-Centric Enterprise, Virtual and Agile Enterprise, Knowledge-based Enterprise, and the Service-based Enterprise. The greatest impact of this convergence is on the value chain. The new value chain does not look like a chain of value-adding members; it looks like a web of virtual enterprises. Two other forces reshaping value chains are perpetual changes in the roles of value-chain members, and customer/consumer preference for personal customization and quick gratification. Collectively, these forces are helping to morph value chains into value webs (Andrews & Hahn, 1998).

Another objective is to gain the synergistic effect of combining knowledge and resources from participating members of the value chain. In electronic commerce, businesses integrate two kinds of activities—those embedded into the physical value chains and others built through information into the virtual chain. Although the relative importance of these two kinds of chains depends on the characteristics of the products and services, their integration plays a critical role in the success of e-commerce. In e-commerce, businesses should understand the implication of the virtual value chain activities. The virtual chain offers a number of distinct advantages over the physical value chain. Some of these advantages lie in forging alliances between customers and manufacturers, advertising products and services with audio, video, and graphics, and saving time and money by efficiently processing customer orders and enquiries. In addition, e-commerce offers flexibility customization of products and service, by reducing the constraints of time and space (Bhatt & Emdad, 2001).

Virtual organizations enable a company to expand geographically, often well beyond what it could have done alone. It has become almost axiomatic that business success depends on expanding the global reach of an organization. Designing effective transnational organizations depend on the effective deployment of advanced information technologies. Because globalization requires employees and business partners to be geographically and temporally distant from one another, deploying information technologies with a virtual organization is an obvious choice for overcoming spatial and temporal boundaries (Boudreau, Loch, Robey, & Straud, 1998).

Virtual supply chains can provide a competitive advantage. Supply chain management encompasses various processes that are supported by coordination and integration mechanisms which yield long-term strategies that give competitive advantage through overall supply chain efficiency. Information technology, by collecting, sharing and gathering data, exchanging information, and optimizing processes, is a key development and the result of these collaboration strategies (Neubert, Ouzrout, & Bouras, 2004).

Building virtual networks or value chains will enable managers to better understand how to develop collaborative relationships that result in a win-win situation. This requires blending concepts and technology in new ways, especially with information and communication technology. One study examined the development of electronic marketplaces, using as references transaction cost theory (TCT) and other network-oriented techniques, such as social network analysis (SNA). In the analysis of the limitations of the TCT, the researchers showed how the "Theory of strategic networks" can contribute to expand our understanding of strategic networks and the various levels of cooperation among enterprises (Rossignoli, 2009).

History (Time Line, Reasons Originated, Principal Developers)

Figure 13E.1 shows the number of articles about virtual management over the past two decades. Beginning in the early 1990s, the number of articles increased rapidly until about 2002, where they started to decline. There may be a bit of a revival, based on the increases in 2009 and 2010. As with most management programs, trade articles were more numerous in the early years with scholarly articles becoming the more predominant type of article as the program matured.

As companies moved from vertical integration to supply chains, they introduced the need to establish communication links with customers and suppliers. Initially, companies focused on the supply side; therefore, the name supply chain became well accepted and meaningful. As companies began to focus more on the demand, or customer side of their business, supply chain did not seem as appropriate, so the term value chain was introduced, indicating the need for the chain, or network, to provide value for the customer. However, because "supply chain" was so well established, it has become the primary descriptor for networks that contain both customers and suppliers as participants.

One early writer viewed virtual networks as dependent on information technology. Corporations worldwide are evolving into virtual enterprises.

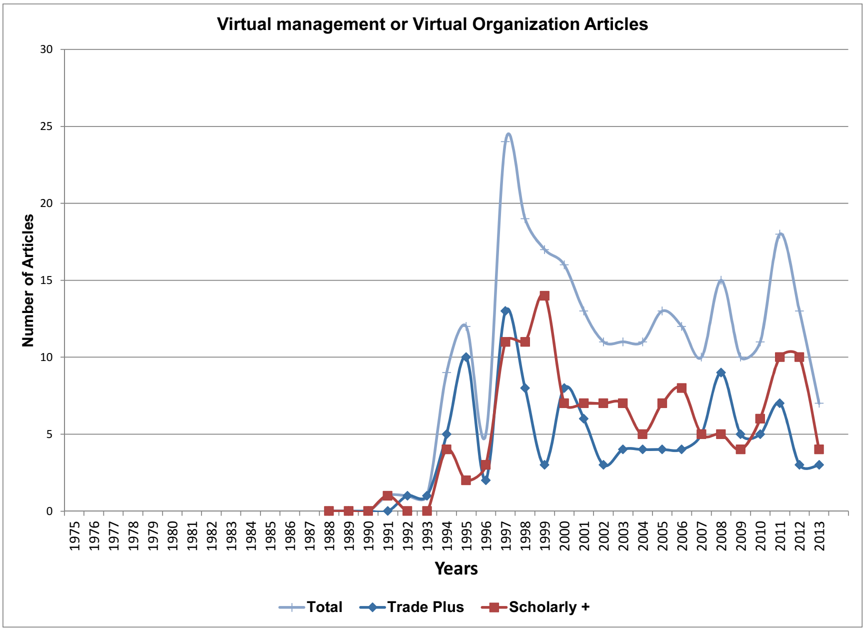

Figure 13E.1. Total number of virtual management articles.

Using integrated computer and communications technologies, corporations will be increasingly defined by collaborative networks linking hundreds, thousands, even tens of thousands of people together. These collaborative networks make it possible to draw upon vital resources as needed, regardless of where they are physically and regardless of who "owns" them—supplier or customer. Several factors are driving businesses toward virtual enterprising. For example, global competition puts corporations under tremendous pressure to cut the time it takes to deliver a product from the workbench to the showroom. Another important factor is an increasingly mobile work force. Traditional offices will shrink to mere landing sites, where mobile workers dock for an hour or so at a communal electronic desk. Virtual enterprises will develop not in the image of the factory floor 100 years ago, but as a new business ecosystem characterized by flexible relationships (Bleeker, 1994).

As supply chains grew in complexity—number of participants—and geographic dispersion—offshore outsourcing—the need for rapid and accurate communication among participants became an imperative. Introducing the flow of information alongside the flow of goods and services required more highly developed information technology systems.

This combination of goods and information flows prompted some writers to introduce the term virtual supply, or value chain.

Among the first to use virtual value chain as a meaningful term were Rayport and Sviokla. They point out that the value chain model treats information as a supporting element of the value-adding process, not as a source of value itself. In order to distinguish value chain from virtual value chain, they describe it as follows:

"Every business today competes in two worlds: a physical world of resources that managers can see and touch and a virtual world made of information. The latter has given rise to the world of electronic commerce, a new locus of value creation. We have referred to this new information world as the marketspace to distinguish it from the physical world of the marketplace" (Rayport & Sviokia, 1995, p. 75).

A retail book store is an example of a marketplace, whereas the sale of books over the Internet is an example of marketspace. The value-adding steps in the latter are virtual in that they are performed through and with information, as opposed to a physical presence.

Today, there appears to be a blurring of the distinctions between virtual supply chains and virtual value chains. Supply chains are called virtual because they consist of participants from different companies who are linked together for a common purpose—to provide goods and services to their ultimate customer. That they use electronic communication to transfer information is almost a given; however, the more tightly connected the participants are, the closer they come to the virtual value chain concept.

Expected Benefits (Tangible and Intangible)

Virtual supply chains are designed to improve performance by reducing costs, increasing quality, shortening lead times, providing greater variety, increasing resource utilization, and improving flexibility. The extent to which they achieve these objectives depends, of course, on conditions, industries, economic environment, and management capabilities, to name only a few.

Another perspective is that virtual organizations are ones that rely extensively on outsourcing, strategic alliances, and other forms of partnering to accomplish their objectives. The core of the organization only keeps functions that cannot be performed more efficiently another way. Virtual organizations may have an advantage in overcoming competitive barriers to entry in particular lines of business—barriers such as economies of scale, capital requirements, access to distribution channels, product differentiation, switching costs, cost disadvantages, and government policies (Fitzpatrick & Burke, 2001).

There may also be some less obvious benefits. One of the current concerns is how to improve the value chain in health care. Pitta and Laric (2004) found that some of the value chain ideas used by marketers in other industries can be of value in health care.

Globalization helps technology leapfrog traditional national boundaries to become more profitable, while technology helps make business more global. Technology is also shortening product life cycles, making businesses less hierarchical, increasing the importance of intellectual assets, and creating fresh sources of competition in unexpected organizations and countries. Driven by information technology and its mutually reinforcing wealth creating interaction with globalization, both the internal and external business environments are being transformed. Business is becoming less hierarchical, faces shorter product life cycles, industrial restructuring based on deconstructed **value chains**, new competitors from unexpected sources and countries, **virtual** corporations, and an era of significantly greater degree of globalization (Aggarwal, 1999).

The heart of the virtual supply chain is the interorganizational system (IOS)—the capability to electronically communicate among participants Chi and Holsapple (2005) expanded the potential for IOSs by compiling the following list of benefits for IOSs:

- Becoming an important source of sustainable competitiveness
- Reducing cost of communication while expanding its reach (time and distance)
- Reducing the number and quality of alternatives while decreasing the cost of transactions
- Enabling tight integration between firms while reducing the cost of coordination
- Facilitating knowledge sharing and trust building
- Expediting expertise exploitation and knowledge application
- Enhancing innovation and knowledge generation

Other motives for implementing IOSs include the need to comply with mandates from regulatory agencies or higher authority, to exert power over other organizations, to pursue common or mutually beneficial goals with other entities, to gain internal and interorganizational efficiencies, to increase agility and responsiveness, to promote innovation, to reduce environmental uncertainty, and to increase its legitimacy and reputation as a progressive member of its peers (Chi & Holsapple, 2005).

Barriers to Acceptance

Building a virtual supply chain faces a number of challenges. Some of the major obstacles are discussed below.

Inconsistency in Strategic Objectives Among Participants

Virtual enterprise and efficient supply chain management systems will shape the future of enterprises. Organizations are striving to become agile enterprises through strategic alliances of firms using information technologies. Traditional performance and cost measures are no longer suitable for developing and managing enterprises in this new environment. In order to remain relevant and to add value, cost and performance measures must be designed and systematically evaluated to reduce the often-unnoticed mismatch between strategic goals and operational tactics (Gupta & Gunasekaran, 2005).

Differences in Participants—Size, Finances, Technologies, Management

Management gurus say that virtual corporations, by concentrating on best-in-class core capabilities and outsourcing slices of their activities that others do better, can integrate and disband painlessly when the job is finished. But beware of one-size-fits-all proclamations. Companies can only outsource and play virtual games when the performance of their products is more than adequate for what customers need. However, when companies have to push the frontiers of performance, managerial coordination is essential (Christensen, 2000).

Lack of Technical Compatibility in Information Systems

In speaking of the PC industry, Dedrick and Kraemer (2005) report, "There are few common standards across the industry, and smaller participants often have minimal IT capabilities. Creating closer links between incompatible IT systems can require costly integration via middleware and custom programming." While PCs represent only one industry, it is relatively progressive with respect to technology. Other industries no doubt have similar problems in linking systems.

Disruption in Existing Organizational Structures

Intense competition and rapid change are destroying predictability. Virtual organizations and many current managerial practices, such as reengineering, continuous improvement, matrix management, and right-sizing, ignore this human need. Such tools are in fact destroying what holds organizations together. As a result, employees keep their resumes up to date and their commitments to a minimum. The best way to approach organizational change is with the realization that dire predictions are better than no predictions at all or positive predictions that no one believes. Managers must make few promises and keep those they do make. The more managers make clear to employees which courses of action will improve their lives, the more employees can focus on creating value (Stevenson & Moldoveanu, 1995).

Lack of Trust Among Participants

The virtual organization has arisen as a result of new technologyies. This new structure, wherein co-workers often do not see each other on a regular basis, calls for reexamination of traditional controls over employee ethics. A traditional business organization is full of checkpoints and control systems that are evidence of a lack of trust. New technologies give employees every opportunity to use their work time for personal matters, and, in a virtual business environment where trust does not exist, managers may fear a loss in efficiency. Checkpoints and control systems can have a negative effect on employees in the virtual organization and requires the nurturing of ethical behavior through a new breed of trust (Ariss, Nykodym, & Cole-Laramore, 2002).

The technological possibilities of the virtual organization are seductive. But its managerial and personal implications require rethinking old notions of control. As it becomes possible for more work to be done outside the traditional office, trust will become more important to organizations. Managers need to move beyond fear of losing efficiency, which makes some cling to expensive and deadening "audit mania." Seven rules of trust are proposed: (1) Trust is not blind; (2) Trust needs boundaries; (3) Trust demands learning and openness to change; (4) Trust is tough; (5) Trust needs bonding; (6) Trust needs touch; and (7) Trust requires leaders. Virtual organizations call for new forms of belonging (Handy, 1995).

Dealing With People Change

The shift towards the virtual organization requires a fundamental change in organizing and managing daily operations. The success of collaborative work therefore relies not merely on the introduction of different technologies, but also on critically analyzing the "human" aspects of organization. Virtual teams bring people together across disciplines, departments, functions, and geographical locations. Virtual teams need to address potential problems before moving forward. These include: information sharing, organizational culture and team working, acceptance of change, and training (Vakola & Wilson, 2004).

Implementation Approach

An implementation program for a virtual supply/value chain is unique for each situation. There is no correct organization structure; it depends on other factors. Throughout most of modern business history, corporations have attempted to unlock value by matching their structures to their strategies. Examples include: Centralization by function; Decentralization by product category or geographic region; Matrix organizations that attempt both at once; Virtual organizations; Networked organizations; and Velcro organizations. But none of these approaches have worked perfectly all the time. Restructuring is expensive, and new structures often create new organizational problems that are as troublesome as the one they try to solve. Given the costs and difficulties involved in finding structural ways to unlock value, it is fair to raise the question: Is structural change the right tool for the job? The authors contend the answer is usually no. It is far less disruptive to choose an organizational design that works without major conflicts and then design a customized strategic system to align that structure to the strategy (Kaplan & Norton, 2006).

Examples of Successful Implementations

Airplanes are a complex product and their manufacture can never be completely done by one company; therefore, it requires a combination of several companies. Because of the complexity, it is necessary that full communications exist among the major subcontractors. Two successful virtual organization projects are described below.

The first study describes how a unique type of virtual team, deploying a computer-mediated collaborative technology, developed a radically new product. The uniqueness of the team—VC3 teams, for Virtual Cross-value-chain, Creative Collaborative Teams—stemmed from the fact that it was inter-organizational and virtual, and had to compete for the attention of team members who also belong to collocated teams within their own organizations. Using the case of Boeing-Rocketdyne, the paper describes the behavior of members of a VC3 team to derive implications for research on virtual teaming, especially for studying teams within emerging contexts such as the one observed here. The data collected also allowed for identification of successful managerial practices and for developing recommendations for managers responsible for such teams (Malhotra, Majchrzak, & Lott, 2001).

A second study looked at the use of virtual organizations in the textile and fashion retailing industry by multinational companies. This study focused on the investigation of the supply chain structures within the two multinational textile enterprises. One enterprise tries to integrate the market side by merging a brand owner. The other seeks an integration solution to compensate from its loss of control of sub-manufacturing sites which during corporate expansion were registered as independent firms. Both enterprises have initiated their global logistics management projects in order to balance the demand and supply. By participating in the two projects, the research indicates the different barriers of integrating toward the upstream and downstream supply chains and provides a mutual solution by building up the e-Fashion global supply chains (Wang & Chan, 2010).

Future

It appears that virtual supply chains will continue to be a popular approach for supply chain participants to pursue. Two scenarios are likely.

Scenario 1: Supply chains continue to grow in complexity and geographic dispersion. Final assemblers continue to outsource component and subassembly manufacture, thereby increasing their foreign sourcing. In addition, product variety and mass customization requirements further add to the diversity of customers. The need to more closely link both downstream and upstream components of the supply chain will require virtual information systems.

Scenario 2: Supply chains will contract as final assemblers to make some of their components or subassemblies, or at least move their supplier base closer (nearsourcing) to reduce transportation costs and potential disruptions. Even if they move work in-house, it will not reduce the need for intraorganizational systems to maintain the effectiveness of their supply chain.

In either scenario, the need for state-of-the-art information technology and telecommunications systems will be a must, not only to maintain flow of goods and services but also the flow of funds and financial information. In today's post-dot-com era, companies need up-to-the-minute financial information and the ability to react more quickly. This new corporate ideal, the virtual finance organization (VFO), must be oriented to achieving the firm's overall business objectives (Jablonsky, 2001).

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CHAPTER 13F

CHAOS AND COMPLEXITY MANAGEMENT

NAME AND BRIEF DEFINITION

Chaos theory finds its roots in mathematics and the natural sciences; hence, the term chaos must be identified within its proper context. Chaos is a state where phenomena that appear to be unrelated actually follow an unknown or hidden pattern called an attractor. Chaotic systems display two characteristics, sensitive dependence on initial conditions and unpredictability in the long run.

Sensitive Dependence on Initial Conditions

Lorenz (1993) noted that a slight change in the initial input of meteorological data could lead to vastly different results. This now famous occurrence led to the popular butterfly effect. This effect states that the flapping of the wings of a butterfly creates tiny air currents that can begin a series of meteorological phenomena that can eventually lead to a larger event such as a hurricane in a specific part of the hemisphere. However, it should be pointed out that it is not so much the occurrence of the hurricane that is important to note; rather, the location of the hypothesized hurricane. In other words, should the butterfly flap its wings in a slightly different variation, the resulting chain of events could lead to a hurricane in a completely different location of the world, or perhaps, to a state of sunshine instead! This important characteristic of a chaotic system, sensitive dependence on initial conditions, thus illustrates that a slight change

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in initial conditions can lead to a vastly different outcome in the system under study.

Unpredictability In The Long Run

The second characteristic of a chaotic system is that the behavior of the system cannot be predicted in the long run. At best, only short-term predictions are possible. Again, the weather is an example of a chaotic system that defies long-term prediction (Lorenz, 1993). While we can certainly predict seasons and general patterns, we cannot predict the specific weather in terms of temperature and precipitation on a specific day of the year; say one hundred days from now.

A system in chaos thus contains these two characteristics, sensitive dependence on initial conditions, and unpredictability in the long run. The reader should note that such conditions actually describe a number of events that managers must address on a regular basis. Hence, there is some feasibility in stating that managers must manage in a chaotic system. However, we can also add several other components that help describe a chaotic system. These include bifurcations, attractors, nonlinear behavior, and self-organization.

Bifurcations

A bifurcation is a point in the behavior of a chaotic system where the outcome can actually vary between two possible values in alternating time periods. The biologist Robert May, made the discovery of a bifurcation while conducting a population model experiment (Gleick, 1987). May found, as he increased the parameter value in his model, the population would increase until it reached a bifurcation point. At this bifurcation point, the population would then alternate values on a two year cycle, reaching a certain value the first year, followed by a lower value the next year, then to return to the original value the third year, and so on. As the parameter was increased again, a new bifurcation point was reached. Now the population values alternated within a four-year cycle. As the study variables were increased again, still more new bifurcation points were encountered until the model reached a state where the value of the population could lie almost anywhere between extinction and a very large amount. The system was in chaos because the population did not seem to settle down to any predictable level.

Even while the system was in chaos, May continued to increase the study variable parameter. Interestingly, when a certain parameter value was reached, the system (i.e., the population level) settled back down to a constant three-year cycle. However, increasing the parameter again caused the system to return to chaos. In fact, the system continued to move in and out of chaos as the parameter level increased.

Attractors

In chaos theory, an attractor is a pattern that forms when the behavior of a nonlinear system is plotted in phase space (Lorenz, 1993). Phase space depicts the different states of the system through various points in time. Such systems produce plots that can resemble orbits. Thus, the behavior of a chaotic system follows a pattern through time.

Attractors range from being fairly simple to vastly complex. Four types of attractors have been identified: Point, pendulum, torus, and strange. Point attractors depict a simple system that constantly returns to a single point. Pendulum attractors vacillate between two points. The torus attractor is a more complex pattern that forms an orbit. The strange attractor, sometimes referred to as a fractal, is a complicated pattern that exists when the system is in chaos. The most famous strange attractor is the Lorenz butterfly, which resembles the wings of a butterfly when graphed (not to be confused with the butterfly effect described earlier).

Nonlinear Behavior

Linear systems react in a proportional or linear manner. The concept of linearity implies that a change in one variable will result in a proportional change in another variable. The result is that the relationship among the variables can be depicted as a straight line. Noting this relationship is important to managers because it means there is some degree of prediction possible using linear based models.

In contrast, the relationships in nonlinear systems depict variables that are not linear, but instead, may be curvilinear, u-shaped, s-shaped, or any combination of these. Since chaotic systems are nonlinear, they do not possess the predictability that linear systems have. Because much of the natural and social world behaves in a nonlinear fashion, chaos theory offers a suitable perspective in examining these systems (Smith, 2002).

Self-Organization

This component of chaos theory describes the system's ability to change itself into a new form without intervention from forces outside the system (Loye & Eisler, 1987). The concept posits that a chaotic stage is necessary first in order for a new system to emerge (Butz, 1997). Closely related to this component is the concept of a complex adaptive system (CAS), a term borrowed from complexity theory. This refers to the ability of an organization to adapt to its surrounding conditions in order to survive (Frederick, 1998).

There is another term we must mention at this point, a concept called "the edge of chaos". This concept was not actually part of the original theory on chaos, but one that has been used by complexity theorists who were attempting to distinguish system behavior that was on the verge of, but not in chaos (Brown & Eisenhardt, 1997). Popular writers have found the phrase intriguing because it represents a crucial area of complexity where management creativity can be at its highest. Following this logic, the aim of management is to operate on the edge of chaos, without actually descending into it.

Objectives (Reasons for Adopting Program)

In this world of increasing complexity, managers would find comfort if they could discover a simple, straightforward answer to their concerns. Unfortunately, none have appeared so far. Complexity and chaos theories are not the answer either; however, they do cause us to stop and consider how their basic concepts could help managers in their decision-making.

Chaos theory does not provide answers; it does help managers develop a new way of thinking about business problems. The bestselling book by James Gleick (1987) made chaos theory understandable to those outside the mathematical and physics disciplines. It was not long thereafter that social scientists, organizational scholars and psychologists found an interest in chaos theory. Finally, there was a framework based on nonlinear occurrences that could be used as a lens to understand the complex social and psychological interactions that make up these disciplines.

The past decade has brought an interest in the application of chaos and complexity theories as a lens for viewing the management of organizations (Burns, 2004). Such work has been seen in the fields of strategic management (Dervitsiotis, 2004; Hurtado, 2006), health care management, public management (Farazmand, 2003), marketing strategies (Mason & Staude, 2009; Samli, 2006), entrepreneurship (Mason 2006), product development (Closs et al., 2008), information system design (Dhillon & Fabian, 2005), flexible procedures design (Brodbeck, 2002), e-commerce (Nelson & Nelson, 2004), organization design (Brodbeck, 2002; Dolan, Garcia & Auerbach, 2003), and the analysis of organizational crises (Crandall, Parnell, & Spillan, 2010; Sellnow, Seeger, & Ulmer, 2002 (Crandall & Crandall, 2010).

History (Time Line, Reasons Originated, Principal Developers)

Chaos theory is not new. Lorenz (1993) discovered the roots of the theory in his attempts to build a mathematical model to forecast weather during the early 1970s. With twelve linear equations containing a number of variables, he found he could predict the weather—some of the time.

However, he found that sometimes the model came up with divergent forecasts, depending on the initial starting point of his forecast period. Even slightly different starting points would result in widely different forecasts! In other words, the results did not follow precisely repeatable cycles, despite the fact that the equations did not change.

At the same time, other scientists—mathematicians, physicists, biologists, social scientists, even economists—were running into similar phenomenon. They discovered linear equations did not capture the full picture of what was happening; consequently, they were forced to conclude the events taking place followed nonlinear patterns. Inasmuch as linear equations were solvable and most nonlinear equations were not, the scientists faced a difficult task. They needed a way to explain what was happening. Even more difficult, they had to convince most of the scientific world that existing theories were not valid—they did not include relevant variations that had been ignored as noise in previous studies. When the variations were small, it did not present a problem; however, in some cases, the variations caused major unexpected and random-appearing patterns, but within a deep-rooted order. For example, in weather forecasting, average temperatures are somewhat predictable from season to season; however, at the beginning of the season, it is impossible to forecast daily temperatures for the entire season.

It is difficult to distinguish between complexity theory and chaos theory because they tend to be used interchangeably in the literature. One typology proposed by Ofori-Dankwa and Julian (2001) distinguished four levels of complexity: Level One Complexity (Simple); Level Two Complexity (Medium); Level Three Complexity (High); and Level Four Complexity (Very High or Chaos). As an oversimplification, we will consider Chaos Theory to be at the most complex end of the Complexity Theory range.

What does that have to do with business? Since Lorenz started his work, chaos theory has been extended in its refinement and application. Researchers work to adapt the theory to business applications and have come up with several conditions to fit the definition of chaos theory, including:

- **Sensitive dependence on initial conditions**—small changes at the beginning can result in significantly different outcomes
- **Unpredictability within order**—while events appear random, there is an underlying order, if it can be identified
- **Nonlinear behavior**—events do not always progress in a linear pattern; the past does not always portend future events.

How do these characteristics fit in business? Considering sensitivity to initial conditions, most agree that timing, such as in new product introduction, is important and the first mover has an advantage, even when they may be only days ahead of a competitor.

Actions by open system entities are often unpredictable. When will the government require more demanding sustainability practices? When will consumers move from reading newspapers to visiting websites for their news?

Businesses have long used the concept of the product life cycle. If you look at the S-shape given to life cycle curves, they are certainly not linear. But where are the inflection points and how do you anticipate them?

Like it or not, businesses appear to be firmly entrenched in an environment described by chaos theory. How do they manage in this new environment? (Crandall, 2010).

Figure 13F.1 shows the number of chaos and complexity articles, classified by trade and scholarly publications. As with most management programs, trade journals published the majority of articles in the first few years, but the number of scholarly articles soon exceeded those in trade journals. This is a subject of considerable interest to scholars, but is still not common practice among businesses.

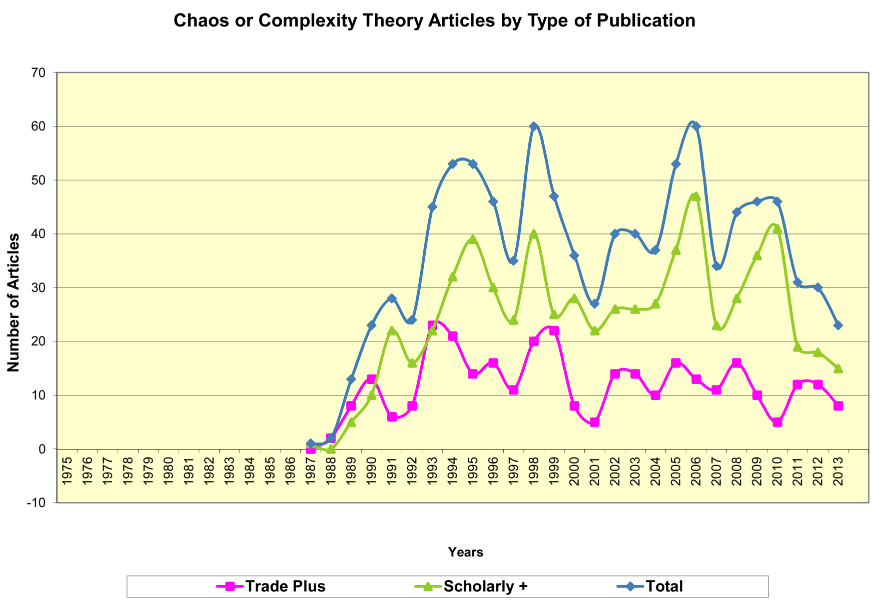

Figure 13F.1. Total number of chaos and complexity articles.

Expected Benefits (Tangible and Intangible)

Benefits can come by understanding some of the positive and negative results that can be related to chaos theory. The better one understands today's business conditions, the better one can prepare for the unexpected. Managers should operate from the mindset that their organizations already exist within a chaotic system.

What this means is that the organization continually finds itself within a system that is similar to meteorological phenomenon. Some days are certainly good days for the organization and life can be very nice, particularly when revenues are high, profits are being realized, and the economy is good. But all of that can change, and change substantially, with just a small jolt in the system. Certainly, the sub-prime mortgage crisis is an example of an initial condition in the economy that changed, causing a worldwide economic collapse. The point to remember is this—the system itself was already a chaotic system, even when times were good. A small change in initial conditions that produces big results is simply a characteristic of this system. Hence, the sensitivity to initial conditions.

Industrial fires offer an example of events that are subject to sensitive dependence to initial conditions. In many of these accidents, a small, almost insignificant factor can serve as the trigger event that causes the fire to erupt. For example, under the right conditions, a concentration of dust can serve as a trigger event. Warner Lambert experienced such an event in November 1976, when a fire and explosion shook its chewing gum manufacturing plant in New York, culminating into a crisis that left six employees dead and 54 injured. The trigger event for the fire was thought to have been a stray electrical spark in the presence of magnesium stearate, a powdered lubricant used in the manufacturing of chewing gum (Sethi & Steidlmeir, 1997). The concept of sensitive dependence on initial conditions maintains that the outcome of this event could have been dramatically different had something in the initial conditions been slightly different. For example, the stray spark was thought to have originated from a machine that was operating beyond its designed capacity, and, in close proximity to high levels of magnesium stearate dust (Sethi & Steidlmeir, 1997). Had the dust levels been lower, or had the machine been operating at its designed capacity, the explosion itself may have never occurred (Crandall, Parnell, & Spillan, 2010).

Examples abound of industrial accidents that were associated with sensitive dependence on the initial conditions of the system. The Exxon Valdez oil spill would have never occurred if the tanker had been on a course just a few meters away from the reef that it hit. In the tragic 1996 ValuJet Flight 592 crash, oxygen canisters were improperly loaded on the aircraft, which lead to a fire in the cargo compartment. Unfortunately, even though cargo compartments are not supposed to have air available to feed a fire, the oxygen containers themselves provided the fuel necessary to escalate the fire, sending the airliner uncontrollably into the Florida Everglades (Greenwald & Hannifin, 1996). Aircraft successfully take off and land every day, but when an accident does occur, it is often because of a slight change in the initial conditions that sends the event into the accident case files.

When operating within a chaotic system, long-term forecasts are difficult, if not impossible. This is a hard assumption for managers, who are in the business of planning and controlling. Nonetheless, their job requires that they make forecasts, define goals and implement action plans, all in an environment in which they often have little control.

To compensate for this lack of ability to make long-term forecasts, some management theorists and practitioners advocate contingency planning. Contingency theory advocates moving away from simple point targets, to exploring a realistic range of possibilities that could occur—possibilities that we say are likely in a chaotic system. However, even contingency planning can suffer from its own problems with long-term planning. For example, should we plan for a range of contingencies 20% higher or 20% lower? But is 20% right, or should it be 25%? This type of thinking can cause managers to regress back to a point target mentality instead of thinking in terms of true range possibilities. Point targets (one number) are seldom correct; therefore, it appears that the targets should cover a reasonable range.

One other response to recognizing that the manager's world resides in a chaotic system is to devote more time to the practice of scenario planning. This type of planning allows for a range of possibilities, and often aims at planning for crisis events. For example, oil companies plan for interruptions of oil in case a war breaks out in a region of the world. This type of planning focuses more on a range of potential events, as opposed to a range of potential outcome targets, such as sales, expenses, and profit margins.

Operating in a chaotic system is a unique mix of stability (strange attractors) and flexibility (adaptation to the changing environment). Technically, the strange attractor is a quantifiable phenomenon found in phase space, However, among management writers, the strange attractor is usually discussed as a metaphor when analyzing organizational life. Management researchers have assigned various descriptions to the strange attractor. Murphy (1996) relates several studies that identify organizational culture as a strange attractor, particularly when an organization experiences a crisis. Organizational culture generally refers to a set of beliefs and values embedded within an organization. For example, Johnson & Johnson's strong belief in a focus on the consumer has been identified as an example of a strange attractor during the Tylenol poisoning crisis in 1982 (Murphy, 1996).

In the organizational realm, Dervitsiotis (2004) identifies unique styles of management as attractors. Likewise, Frederick (1998) ascribes an organization's values as its strange attractor. From this perspective, values can be likened to an organization's culture discussed previously. In other words, it is the organization's values that hold it together while it is going through the turmoil of a crisis.

From the crisis management literature, Sellnow and associates examined the 1997 Red River flood in Minnesota and North Dakota from a chaos theory perspective. They proposed that the United States National Guard and Federal Emergency Management Agency (FEMA) were the strange attractors since both agencies were instrumental in bringing order to a situation that was in the midst of a crisis. Thus, Sellnow's viewpoint maintains that the strange attractor can literally bring stability to a situation that is in chaos (Sellnow et al., 2002).

The implication for managers is this; some stability is needed to maintain the integrity of the organization during difficult times. However, the stability implied by a strange attractor is not the same as maintaining the status quo. The status quo usually implies that a change is needed in order for the organization to move forward. Furthermore, there are times management must move the organization through the change process so it can re-adapt to its new environment.

For example, changes to the organization are usually inevitable when a crisis hits. From a manager's perspective, the concept of self-organization asks the question: how does the company look different from what it was before the crisis? The 1997 Red River Valley flood resulted in an array of self-organization for the political units involved in disaster relief for that area. Murphy (1996) maintains that within a chaotic system, changes will also occur in the organization's system, changes that create a new order with positive dimensions. Sellnow and colleagues discussed how the 1997 Red River Valley flood prompted a reorganization of emergency services between the adjacent cities of Moorhead, Minnesota and Fargo, North Dakota (Sellnow et al., 2002). On the positive side, the two cities were formerly rivals, but after the flood, cooperative structures emerged whereby crisis communication was centralized through Fargo's City Hall.

Operating on the edge of chaos is the norm, not the exception. If managers assume that they are always operating in a chaotic system, they no longer seek equilibrium as their goal, but instead, adaptation. With this assumption, they realize they are always operating on the edge of chaos. (Remember, chaos is simply that region within the chaotic system where they cannot make an accurate prediction, at all).

From a psychological viewpoint, the ability to function at the edge of chaos can spawn creativity and problem solving (Richards, 1996). Managerial writers have advocated that operating at the edge of chaos can be a good thing. The pressure it puts on organizations causes management to change the organization for the better or else die in the process. In fact, some note that organizations seeking to operate at a comfortable equilibrium may actually be in danger of failing in the long run (Pascale, 1999; Singh & Singh, 2002). Certainly, this is not a new observation by any means, as those in the strategic management field have been saying this very thing for years. What chaos theory does is to help us understand why this observation is true.

Brown and Eisenhardt (1998) have this to say about competing on the edge of chaos:

> Intense, high-velocity change is relentlessly reshaping the face of business in fledgling high-tech ventures and Fortune 500 giants, in steel and silicon alike. Everywhere, and in every industry, markets are emerging, closing, shrinking, splitting, colliding, and growing—and traditional approaches to business strategy are no longer adequate. To thrive in these volatile conditions, standard survival strategies must be tossed aside in favor of an entirely new paradigm: *competing on the edge.* Competing on the edge is an unpredictable, uncontrollable, often even inefficient strategy, yet a singularly effective one in an era driven by change. To compete on the edge is to chart a course along the edge of chaos, where a delicate compromise is struck between anarchy and order. By adroitly competing on these edges, managers can avoid reacting to change, and instead set their own rhythmic pace for change that others must follow, thereby shaping the competitive landscape—and their own destiny.

In his classic bestseller, Christensen (2000) suggests successful companies may be the most reluctant to change, because they believe what they are presently doing is what made them successful. As a result, they may suffer when their entrenched or "sustaining" technology is replaced by "disruptive" technology from a new competitor. He suggests that disruptive technologies rarely make sense during the years when investing in them is most important; consequently, conventional managerial wisdom at established firms becomes an entry and mobility barrier that entrepreneurs and investors can count on (Christensen, 2000).

Operating at the edge of chaos implies that with no equilibrium to retreat to, management must assign themselves the task of adapting and working through critical points in the organization's history. Andrew Grove, CEO of Intel, strongly supports the need to manage in turbulent times in his book *Only the Paranoid Survive, How to Exploit the Crisis Points that Challenge Every Company and Career* (1998). He describes how strategic inflection points must be confronted and managed during the life of a company. If managed correctly, strategic inflection points can be an opportunity for growth and success (at least until the next strategic inflection point occurs); if managed incorrectly, it can mean the demise of a company. He recalls the crisis faced by Intel during the 1980s when they struggled with the decision to vacate their strong position in memory chips and move more aggressively into microprocessors. Grove points out other strategic inflection points—superstores replacing neighborhood stores, talkies replacing silent movies, shipping containers replacing stevedores, and wireless communications replacing landlines. He stresses that strategic inflection points are difficult to identify ahead of time, especially for successful companies and suggests that top management listen carefully for early warning signs of change, both from within their company and from external sources.

Barriers to Acceptance

There has been an abundance of enthusiasm for the use of chaos theory in business applications among those in both the academic and popular business media. However, several cautions are in order. First, some have advocated chaos theory to be a superior framework to more traditional linear models when analyzing organizational problems. Second, a number of writers have been guilty of semantic misunderstandings on the meaning of the term chaos. Consequently, we offer the following two caveats in reference to these viewpoints.

Chaos Theory Has Been Over-Enthusiastically Endorsed as a "Cure-All" In Organizational Research Applications

Chaos theory has been offered by some as a superior framework in the analysis of organizational events. The rationale touted is that most organizational problems transpire in a nonlinear manner; therefore, these problems should be analyzed using a nonlinear perspective (Farazmand, 2003). While there is some logic in this perspective, there is also the temptation to downgrade the linear approaches to forecasting and problem solving that have built up our knowledge in the business field over the past several decades. Much of the business and organizational research in management is based on these linear perspectives. To imply that chaos theory is somehow superior or exclusive means we must cast off the significance of previous research that used these linear approaches.

There is however, another problem with advocating the superiority of the chaos theory perspective—little empirical research in the management field is available that validates chaotic conditions. Instead, we must assume organizational life is nonlinear (and hence, capable of chaos) because we say it is. This leaves the management theorist/researcher and the popular press business writer in a bit of a quandary on how to use chaos theory at all. Thus, for the management researcher, the use of chaos theory is usually one of a metaphor, not a strict statistical tool that seeks to plot values in phase space. Indeed, the use of metaphors can be useful in understanding complex organizational systems (Morgan, 1997).

If we downgrade the application of chaos theory to a metaphor, does it mean it is no longer a superior framework to linear approaches to solving problems? Or, put another way, can chaos theory actually tell us much that cannot be explained with existing theories (Kincanon & Powel, 1995)? We believe chaos theory will add "some" unique perspectives to our body of knowledge on business and organizational life. It does provide a useful metaphor, but not necessarily a superior perspective that outclasses all other approaches. We offer that chaos theory is one of a number of tools and perspectives available to the organizational researcher and manager, but it is not one that should be assigned elevated status over any of the other perspectives.

There are Significant Misunderstandings of the Word "Chaos," Especially Among Popular Business Writers

The most significant caveat that can be put forth in the context of this discussion is drawing attention to the apparent misunderstanding of the word chaos. Within the context of chaos theory, chaos refers to a system state characterized by sensitive dependence to initial conditions and unpredictability in the long run. However, some have used the more familiar definition, a state of being where events are random or out of control, to signify chaos. This comparison is incorrect (Kincanon & Powel, 1995) although one could see how the two definitions of chaos may be confused.

For others, the concept of chaos carries with it a sense of mystery and excitement about life (Stoppard, 1995). The appeal of chaos theory has been likened to a romantic appreciation of disorder that accompanies a corresponding reaction against the scientific appreciation for order and symmetry. One could further extrapolate that such a viewpoint advocates liberation from the constraints and bondage of a world obsessed with trying to bring order to every issue imaginable (Friedrich, 1988; Smith & Higgins, 2003). As we have pointed out though, this perspective is not consistent within the context of chaos theory.

Implementation Approach

How do businesses confront a chaotic world? Several authors provide ideas about how to successfully adapt to changing conditions. Frederick (1998) describes some of the characteristics a business needs to thrive in a chaotic world. They include:

- **Self organization**—an innate spontaneous, sometimes hidden, capability to move toward order, rather than disorder
- **Autocatalytic component**—the tendency for the movement toward self-organization to speed up and sometimes change direction unless controlled
- **Complex adaptive system (CAS)**—the ability of an organization to adapt to its surrounding conditions in order to survive
- **Fitness landscape**—the environment in which a company operates. Fitness landscapes are dangerous places. To avoid disaster, each CAS seeks a secure niche within its fitness landscape. Vigilance, cleverness, flexibility, and creativity are the qualities that maximize its chances of success.
- **Edge of chaos**—a space on the fitness landscape in which a CAS may become unstable. Opportunities abound, but so does disaster. Unless checked, a CAS may disappear in a flurry of uncontrollable, dizzying oscillations and disappear over the edge of stability into the chaos zone and beyond. When this happens, it dies.
- **Strange attractor**—the force that enables a CAS to hover on the edge of chaos, where it can generate new adaptive skills—technological innovations or new market awareness—and maximize its future possibilities. Company visions or strong leadership may provide this capability.

One of the more provocative ideas is the concept of "weak signals" as they relate to complex adaptive systems (CAS). A weak signal is an early warning that something is going to change. It may be an isolated field failure because of wear in parts (Toyota), an announcement that a retailer is adding a food section to its "big box" store (Wal-Mart), or that an online retailer is exploring the feasibility of using drones to deliver packages (Amazon). In most cases, the signal may not have any implications for your business. However, you may want to have someone, or several persons in your organization, be on the lookout for those potential changes that will have an impact. Improvement programs, such as Total Quality Management (TQM) and Six Sigma that reduce variability may stifle recognition of weak signals that herald innovative approaches, products, and solutions. Weak signals are not quantifiable in the normal sense; they must be identified and then amplified if they are to be useful. "Oscillating within the edge of chaos is the rich environment in which weak signals are most likely to be found" (Harris & Zeisler, 2002).

Toyota's past experience with recalls is evidence that situations change dramatically, often seemingly arising from a small change in initial conditions that was not initially considered to be a major event. Risk and crisis management is a growing concern for many companies (Crandall, 2010). A recent book provides the following links between crisis management and chaos theory:

- Little things (initial conditions) matter in relation to an organizational crisis.
- Long-term predictions of future crises are difficult to make.
- Bifurcations represent key turning points whereby the crisis can be brought under control or can escalate out of control.
- There are hidden patterns (i.e., attractors) in almost everything, including the causes of a crisis and the way it is managed.
- A certain amount of order and disorder is natural and even healthy for the organization.
- Finding the cause of a crisis may be more difficult than originally anticipated.
- Whether management realizes it or not, the organization is changing constantly (Crandall, Parnell, & Spillan 2010).

Future

Murray (2003, pp. 416–417) offers the following conclusions about complexity theory:

- It is clear that complexity science provides a number of useful metaphors, which enable sense-making of many aspects of current organizational life.
- None of these have been 'proven' to work (in the sense of providing a comprehensive theory), and it is difficult to see how the theory could be tested.
- Nevertheless, complexity theory is an exciting development, because it appears (at least to those of us with a natural or biological sciences background), to offer the hope of explaining, or at least making sense of, organizational phenomena which are complicated.

- While complexity theory may one day provide an over-arching explanation of complexity and change in organizations, in many cases its insights appear to be representations of existing ideas and knowledge.
- Finally, the framework provided by Ofori-Dankwa and Julien (2001) is a useful tool for analyzing the insights of complexity, and in some cases suggests that they are not all as 'complex' as might at first appear to be the case.

How do you use it in your business? Is chaos theory going to be a management fashion with lasting influence or is it just a fad? There are indications it has staying power and should be given attention by progressive managers. What should you do?

- Recognize chaos theory exists and is receiving serious attention by both practitioners and scholars. Learn more about it.
- Prepare for the unexpected by developing an agile organization. Although this is a reactive response, it is better than being caught by complete surprise.
- Organize to search out weak signals and exploit them (this is a proactive response). One way of doing this is the use of large group interventions, a way to "increase an organization's potential for amplifying ideas and generating radical change through self-organization." (Arena 2009)
- Recognize you will spend money on ideas that may prove worthless; however, you may hit a bonanza once in a while. Perhaps even more important, you will not as often be surprised by new developments that are disruptive to your business (Crandall, 2010).

ACKNOWLEDGMENT

This topic has been largely adapted from a paper by the authors entitled "Understanding the Chaos behind Chaos Theory: So What's in it for Managers?" Published in the SEINFORMS 2010 Proceedings.

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CHAPTER 14

SELECTING THE CORRECT MANAGEMENT PROGRAM

Is there some simple way to select the correct management program for your organization? While we don't think the selection process is simple, there are some general guidelines we can provide that may help. We have classified the programs in what we believe is their primary objective; however, as we discussed earlier, some of them are presented as multi-purpose; that is, they can provide more than one benefit.

Perhaps this idea of multi-purpose can best be explained by thinking of any of the programs as promoting better management. Therefore, any program that promotes better management can lead to multiple benefits.

Here are some general guidelines. They are not simple steps that can be followed without adapting them to each situation. Implementing management programs require more than a simple decision to do it.

1. **Clearly define the problem you want to solve.** If you don't have any problems, don't bother installing a management program. If you do have a problem, you want to find a program that provides a solution to your specific problem. For example, if you have a problem with field failures of your product, you probably need one of the quality improvement programs. It is not likely that adopting a Balanced Scorecard program or implementing an ERP system will lead you directly to a quality improvement. They may help you identify your problem, but you probably already have a good idea of problems you want to solve.

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2. **Pick a current version of the management program.** We have tried to show that some of the earlier programs, such as MRP or TQM have morphed into later versions of ERP and Six Sigma. This does not mean the later versions are complete replacements for the earlier versions. Sometimes key points can be lost during translation.
3. **Separate the management fashions (those programs with staying power) from management fads (those programs that have come and gone quickly)**. Check out the figures for each program that show the number of articles that have been published. We selected programs we believe are fashions and have durability. If we omitted a program, it doesn't mean it isn't worthwhile; it just means we ran out of room to include it.
4. **Involve some of your key managers in the program selection.** Build a consensus in narrowing down your choices. While the CEO may make the final decision, it is helpful to have multiple inputs. Sometimes managers may have experiences from other organizations that are relevant to the program being considered.
5. **Get input from your colleagues at other organizations.** In today's age of rapid and extensive contacts through professional organization networks and even social media sites, it is easy, and often revealing, to hear what others say about some of the management programs. You may have to filter the input but it may also be worthwhile.
6. **Remember that any program takes an investment in time and money.** None of them can be implemented without top management support. The implementation also means that organizational infrastructure and cultures will be tested, if not significantly changed, if the program is to be successful.
7. **There is no substitute for rational and objective judgment.** It is easy to get caught up in the enthusiasm of writers who have little to lose if your program fails. While consultants can be very helpful in directing your thinking toward worthwhile initiatives, they also may emphasize the positives of a program and minimize the potential obstacles.
8. **Finally, you must, at some point, make a decision about whether or not to pursue an improvement program, and, if you do, select the correct program.** View it as an opportunity, not a threat. Have confidence in your ability to make the correct decision.

As a guide to the critical decision areas of selecting a management program, we have included below an abstract from the authors' book *Vanish-*

ing Boundaries, How Integrating Manufacturing and Services Creates Customer Value.

Why Are Some Programs Successful and Some Not?

Some management programs enjoy great success as they are widely heralded in both trade publications and scholarly journals as leading edge evidence of how companies can become more competitive. The same program, in another company, may achieve only limited success or even be considered a failure. Why is there so much discrepancy in success among companies that allegedly implement the same program?

The movement of a management program from one company to another involves a great deal of knowledge management (KM). Knowledge management systems (KMS) require liberal amounts of technology; however, their eventual success depends on supplementing technology with systems and people skills.

"The development of KM strategies for knowledge transfer is a dynamic and complex undertaking. A principal belief within organizations is that the ability to compete based on knowledge depends primarily on people, rather than processes or technology. Strategies that guide the sharing of internal knowledge represent great challenges" (Wakefield, 2005, p. 943).

The originators of individual programs considered them a success; otherwise, they would not have promoted them. Have followers, or later adopters, of these programs been as successful? Some have but many organizations have had limited success or considered the programs as failures. Why is this so? Is it the program or the situation? Figure 14 1. suggests that the answer must be in the fit between the program, as a proposed solution, and the problem or need of the business. Lack of success must arise from the incorrect matching of the program to the need, or the failure to implement the program correctly. Let's look at each of these possibilities.

Failure to Match Program with Need

Figure 14.1 shows conceptually what happens when programs are applied. The originator (or first company) is successful; a close follower using that program is also successful, most likely because they have an operation that is very similar to the originator. Additional followers that are similar to the first company can implement the programs and also achieve success. As the program grows in popularity and the success sto-

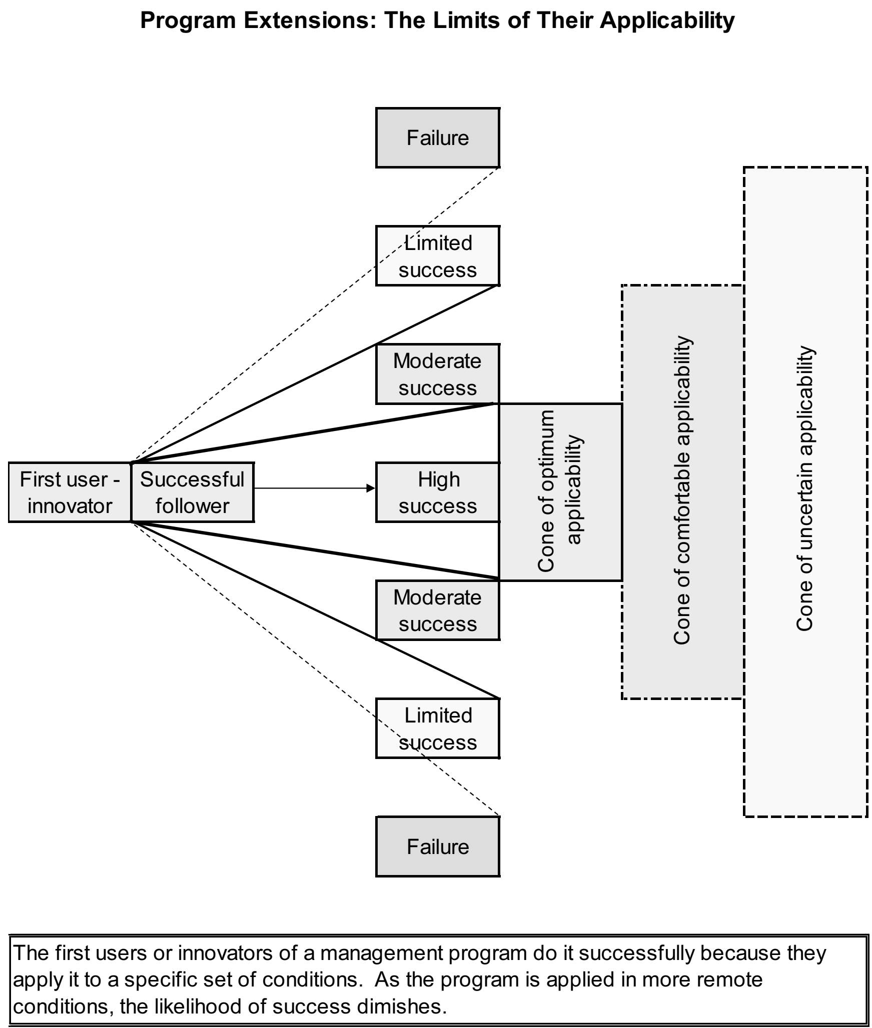

Figure 14.1. Program extensions and their chances for success.

ries abound, other companies implement the program. As the program is extended into businesses that are different from the originator however, the level of success varies and, in some cases, the program may actually be considered a failure. Conclusion: managers should match the program carefully with the needs of the organization.

As always, there is an alternative and that is to adapt the basics of the program to the different conditions of the business. Figure 14.2 shows a

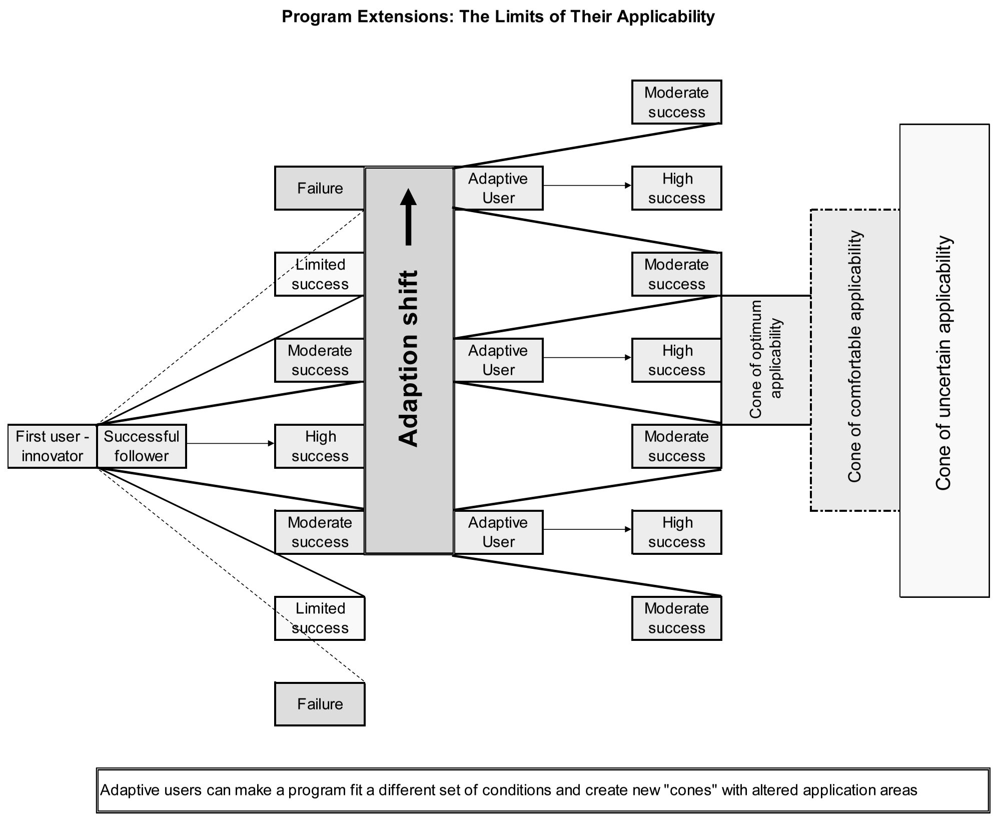

Figure 14.2. Adaptation of programs to new conditions.

conceptual model of this approach. As the conditions change, the adopter modifies the program elements or selects those elements that fit the new need. In general, the greater the difference in conditions in the new environment, the greater the need for adaptation.

Decision Variables

Conditions vary for a number of reasons. We describe several that are among the most likely differences that could affect the eventual success of a management program.

Strategic objectives. Strategies vary among companies. One company may want to focus on cost reduction while another company may focus on quality improvement. Each has different needs; therefore, each company may utilize a different program.

Types of products or services. Product volumes and variety vary. A business that thrives on high variety, low volume products should not expect that a program developed for high volume, low variety products would fit their needs, at least, not without some modification. The same is true for a line of service offerings. An inventory management program developed for widely fluctuating demand patterns, such as in a seasonal retail business may have more variations than needed for a stable demand business, such as the bread and milk departments of a retail grocery store.

Types of processes. Manufacturing processes can be generally classified as job shop, batch, repetitive and process. Service processes have been classified as a function of the degree of customer contact, such as high contact (hospitals) versus low contact (computerized banking). The wide range of requirements make it difficult to apply the same program equally well to all types of processes. As with product variations, some modification to the program would be necessary to address different conditions.

Centralization versus decentralization. Decision-making is generally classified as centralized or decentralized. There are somewhat opposing trends evident today. The influence of the human relations movement is moving companies toward empowered employees, which suggests decentralized decision-making. However, the widespread availability of information at all levels of detail is making centralized decision-making feasible as well. It is important that management programs recognize the possible differences that can exist between these two approaches.

Cultures. Cultures among businesses range widely. Internal factors may cause some of the differences, such as level of employee empowerment, level of job scope, types of wage payment systems, and management styles. External factors that influence the culture of a business include the demographics of the region in which the business is located and social trends. However, it is essential that the management program be adapted to the existing culture, or the existing culture modified to be compatible with the management program. It should be noted that modifying an organizational culture may be more challenging than modifying the management program.

Top management support. Almost unanimously, authorities stress the need for top management support in the design and implementation of management programs. However, what top management support means can vary widely from business to business. This type of support is dependent on management styles, the relative importance of the program, the background and experience of top managers, and the relationship of top management to the external stakeholders in the program, such as consultants, customers and suppliers.

Industry traditions. Some industries have unique origins, practices, language and peculiarities. Many improvement programs arise and are successfully installed within a particular industry. For example, JIT and Lean manufacturing are associated with the automobile industry; Quick Response systems with the retail industry; and MRP/ERP systems with repetitive manufacturing of all types. To implement a management program in one closely related industry to another may be a small step, such as from manufacturing washing machines to refrigerators. However, to move the same management program from automobile manufacturing to railroads or the health care industry may be a major transition because of the embedded practices within each of these industries. In some cases, a program will not gain any degree of acceptance until the terminology is changed to fit the industry where the program is being introduced.

Because of the foregoing reasons, a management program needs to be adapted to its proposed application area if it is to have a chance of success. Even if fitted correctly, it then must be correctly implemented, as we will see in Chapter 15.

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CHAPTER 15

PROGRAM IMPLEMENTATION

Once you have decided on a program, you need to implement it. If you have selected the most appropriate program, you have a good start. However, even if it is the right program at the right time, many programs fail during implementation as a result of inadequate planning and preparation.

A GENERAL APPROACH

We have included an implementation section for each program to indicate some of the key points to consider. Some programs have unique requirements that are keys to its success. Below, we provide some general thoughts to help in the implementation process.

- **Implementing a management program is a project and requires careful planning**. A project plan requires a clear description of each task, the person(s) responsible for its completion, the persons to be involved, the precedence relationships among tasks, and the expected duration of each task. While careful planning can prevent problems, even the most diligent plan will require modification and adaptation during the implementation process.
- **Appoint a specific person to be responsible for the success of the program.** It is critical to assign this responsibility to someone who not only has the competence but also believes in the program.

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There will be obstacles to overcome; the leader must be able to anticipate some of them ahead of time; however, there will be some that arrive unexpectedly. The program manager must deal with them quickly to prevent unnecessary delay or deterioration in the program.

- **Be aware that any program must be adapted to fit your organization**. The technology of the program (the processes inherent in its operation) must be changed to fit your operation or your operation must be altered to fit the processes in the program. Often, there is a need to change your policies and organization structure to accommodate different ways of doing things. Almost always there is a need to modify the culture of the employees to accept change.
- **Pick a good starting point**. Most programs will span multiple departments, functional areas, even separate locations. Start where there is a need, but also where there is a high likelihood of success. It may be a receptive manager, or a problem that can demonstrate the validity of the improvement program. Don't risk the success of the entire program by trying to force it into an area where there is a low chance of its acceptance.
- **Select a team that will get the job done**. The implementation team must include members that have the technical competence needed, such as in operations, accounting, information technology, human resources and engineering. They must also learn to work together, an outcome that may take some time to develop. Some members will have to be reassigned from their regular job to work full-time on the program; others will be able to do what is needed part-time.
- **Provide appropriate top management support**. Too many executives give a rousing send-off to a program with a carefully prepared speech and then ignore the program until it runs out of steam or encounters a disaster. Top managers shouldn't micromanage, but they should be interested, provide resources, be available when needed to help work through a problem, and reward the team as they achieve successful completion of each phase of the program.
- **Recognize that the day-to-day work will be affected by the program implementation**. The new program will bring change to the organization, and change is sometimes difficult to accept. It interferes with the normal work and new processes will always seem more difficult than the old way. Deal with objections and delays in a considerate, but forward-looking approach. Working through these interruptions will test the ability and perseverance of the program managers.

- **Prepare for the end of the program implementation**. At some point, it will be necessary to call an end to the program implementation. Hopefully, the new processes will be firmly in place and employees are trained and receptive to the new way of doing things. The program elements should become the "new normal" way of doing things. Publicize the successes so that the program has a positive image for employees and plan to move on to the next new program.

On the following pages, we have adapted materials from an article written by one of the authors about implementing change management programs (Crandall, 2011).

Implementing Change is Like Playing Tic-Tac-Toe, You Have to Align the Three Unknowns (Xs) of Technology, Infrastructure and Culture

Implementing management improvement programs is a common requirement for most businesses. Normal, ongoing "steady as she goes" operations are a thing of the past. Companies that aren't continually making improvements are destined to fall behind their competitors and eventually wind up as examples of "failures to act." While the need to act may be obvious, managers do not always get it right.

In this section, we hope to focus on an approach to implementing improvement programs that embodies some of the key elements of a program to manage change—technology, infrastructure and culture (TIC). The acronym suggests a game all of us have played at one time or another—tic-tac-toe. While the connection between a simple game and managing change may seem remote initially, we hope to show there is a valid relationship.

The Game

You remember the game, don't you? It starts with a diagram as shown in Figure 15.1. All you have to do to win is get three Xs or Os in a straight line, as shown in Figure 15.2. X usually starts and, in Figure 15.2, X wins (for our discussion, successfully implements the management improvement program).

The game is known by a number of different names, including wick wack woe (in some Asian countries), and Noughts and crosses (UK, Australia, New Zealand, South Africa, India and the rest of the British Com-

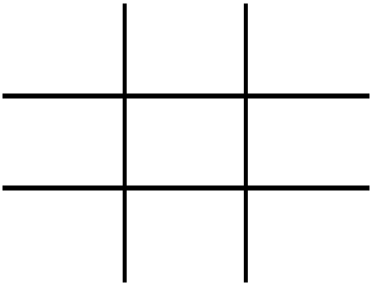


Figure 15.1. The game to start.

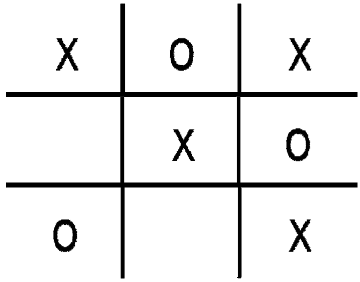


Figure 15.2. The winner.

monwealth countries). The earliest known variant of tic-tac-toe originated in the Roman Empire in the first century B.C. and has been expanded to 3- and 4-dimensional games.

Although it is a simple game that small children can learn to play, it can be deceptively aggravating. First of all, the number of different board layouts can equal 3^9, or 19,683. If that weren't enough, the number of different sequences for placing Xs and Os = 9! = 9 x 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 = 362,880. A player can play perfect tic-tac-toe (win or draw) if they move according to the highest possible move from the following table (sorry, not enough room to include the table). A computer developed by MIT students made out of Tinker-Toys has never lost a game! (Wikipedia, 2011).

Why is managing change programs like tic-tac-toe? There are several reasons:

- Both sound easy, but they aren't
- Both require a strategy to complete successfully
- Both involve alignment of different key components
- Both require a response to external factors
- A tie is better than a loss
- You should plan to never lose!
- You start with "tic."

Change Agents

What are the change agents of a successful management improvement program? In a broad sense, they include technology, infrastructure and culture. Each of these terms needs further clarification.

Technology

The APICS Dictionary defines technologies as the terms, concepts, philosophies, hardware, software, and other attributes used in a field, industrial sector, or business function. (Blackstone, 2013). This definition is so broad that we need to look further. Bessant and Francis offer this observation on technology:

> Some technologies are 'hard', for example, cellular telephony, and railway signaling or electricity generation. However, 'soft' technologies also need to be transferred.… There are significant debates about the meaning of the term 'technology'. Some, who we describe as the 'hardware school', define technology as the construction and use of machines, systems or engineering. Others, the 'socio-technologists', take a broader view and consider technology to be meaningful only when it becomes a social fact … we adopt a socio-technological viewpoint and, simply put, we see technology as 'ways that people get complicated things done.' (Bessant & Francis, 2005, p. 96)

Without technology, there would be no manufacturing, but manufacturing is more than technology. It is also about people and their relationship with the technical resources of an organization. Manufacturing is about organization, people, technology, management accounting, business strategy, and so on. It is also about the connections between all these dimensions. In the past, we have tended to ignore not only the connections, but also some of the dimensions. We have placed too much faith in technology, using technology to compensate for inadequacies elsewhere, and trying to solve all problems as though they were technical problems.

While technology is ambiguous, it is essential for the success of improvement programs. Technology is anything that enables a person or an entity to do something differently, hopefully better than before. In this sense, it is a driver of change. Perhaps that explains some of the resistance to the introduction of new technology; it is the introduction of change. It may cause a change in how we do things, such as the use of PCs instead of typewriters. It may change the way we think, such as when we set goals of zero defects instead of a range of acceptable defects. It can even change the way we manage, such as with self-directed teams instead of through a "show and tell" use of job specialization (Crandall & Crandall, 2007).

Infrastructure

The term infrastructure may be even vaguer than technology. It is often associated with roads, bridges, and other public programs. It is also used in the military to designate support organizations such as parts depots and replenishment supply chains.

Many managers with degrees in business might remember taking a course that dealt with the subject of infrastructure. Certain terms have probably remained in your memories, terms such as span of control, centralization, organizational charts, departmentalization, and specialization. In fact, managers use these concepts frequently in the everyday running of the firm; they are not just textbook terms.

What are the components of infrastructure? There is no set list as that would vary from business to business. However, as a starting point, the following components could be considered part of most business infrastructures:

- Strategies—to fulfill the mission and goals of an organization
- The four classical management functions—plan, organize, direct, control
- Organization structure—vertical, horizontal, matrix, network
- Knowledge management—implicit and tacit
- Policies, procedures and practices

We will consider infrastructure to be the inanimate guidelines of how things should be done. It includes the mission of a company outlining goals and programs. It also includes operational considerations such as the organizational structure, policies, procedures and plans. The infrastructure of a business provides the framework within which technology helps employees get things done (Lester & Parnell, 2006). See Crandall and Crandall (2014) for a fuller discussion of infrastructure.

Culture

Culture, or the belief systems inherent in the organization, is another vague, but important, ingredient of successful management improvement programs. It includes the human side of the business and the vision of the company that sets out a philosophical approach to running the business as contrasted to the mission that portrays the tangible objectives of the business. The culture also includes the image of the company as perceived by persons within the company and those outside the company, whether customers or other types of stakeholders. Corporate cultures are formed by the history of the company—how it has operated over its lifetime, by the management styles of key executives and, most importantly, by the employees and their collective way of acting.

Businesses and non-profit organizations can have their own culture. For example, Southwest Airlines is one of the most talked about companies in the business media. One reason is their unique culture that is based on having fun at work and incorporating a sense of humor into the workplace. The culture stems from the founder, Herb Kelleher, whose zany and outgoing personality have dazzled admirers from the business world for years. The culture is reflected through the employees, who like to make flying fun for their passengers (Carrell, Jennings, & Heavrin, (2006).

Organizational culture is important, yet it is also one of those "touchy-feely" kinds of topics that make some executives feel uncomfortable. However, one of the early writers in the area, Linda Smircich (1983), has identified four down-to-earth reasons why organizational culture is important. She prefers to call them functions of culture. The functions of culture give the company an identity, help an employee make sense of things, enable employees to be committed to the company, and adds stability to the organization (Crandall & Crandall, 2014).

Attributes of the Change Agents

The change agents of technology, infrastructure and culture can assume a number of different roles during the implementation of a management improvement program. Ideally, they will work together in a coordinated fashion for best results. Their roles, which we introduce as representative, can include any of the following and often more than one during the lifetime of a program.

Barrier. In this role, the change agents act to block any additional progress in the program's implementation. The program may reach the point where improved technology is required before continuing—for example, the need for lower prices on RFID tags. Infrastructure can be a barrier if there is a need for an agreement on profit sharing between two entities. A union contract can also be a barrier if proposed changes can have an impact on the job security of the existing employees. In terms of organizational culture, "organizational members will resist changes that force them to abandon established assumptions and approved ways of doing things" (Cook & Hunsaker, 2001, p. 535).

Restrictor. In this role, the change agents "drag their feet" in the improvement program. The EDI system works but has intermittent problems. The organization structure retains its vertical orientation and slows the need for horizontal communications. The employees are not able to spend enough time on the new program, either because of other required duties or because of reluctance to "buy in" to the new program.

Participant. All of the change agents are moving along rather well. The reverse logistics process is working with only minor hitches that can be resolved on a day-to-day basis. The policies and procedures align sufficiently to avoid conflict among internal and external entities. The differences between the "way we have always done it" and "this is the new way" have been reconciled so that the employees are able to do their jobs without undue interference.

Enabler. In this role, the change agents participate in a "more than expected" manner. On the technology side, the sales and operations planning system is providing benefits to both the demand and supply sides of the business. The matrix organization structure is enabling employees to work on the program without leaving a major gap in their regular assignments. As an enabler, the employees are compensating for the deficiencies in the IT system or the organization structure.

Driver. In this role, a change agent is the leading force in moving the improvement program along, often in spite of other parties being in a restrictor or barrier role. The automated point-of-sale system offers so many benefits that it creates tremendous pressure on the infrastructure or the culture to "get with it." When the infrastructure assumes this role, it means that the conditions have been arranged so that the technology (when it is done) and the culture (when they buy in) will move without interference. The culture can act as a driver when there is a consensus among the employees to "do it."

Phases in Management Improvement Programs

A continuous improvement program passes through several phases in its journey to success. For a more comprehensive discussion of program life cycles, see Abrahmason and Fairchild (1999) and Crandall, Crandall, and Ashrah (2006). These phases include:

- Discovery
- Design
- Implementation
- Adaptation
- Assimilation
- Consolidation

Discovery. This phase marks the beginning stage of the management improvement program. It is the equivalent of the birth stage in the product life cycle. The discovery process can result from either of two situations. The company finds it "must" do something or fall into financial difficulties, or it "can" do something because of a new idea that they have discovered. In the first scenario, the company is aware that unresolved problems impact the bottom line. In the second scenario, an improved process may look attractive because other successful companies are implementing it in their organizations. At any rate, the threat or opportunity ranks high enough in management to get their attention.

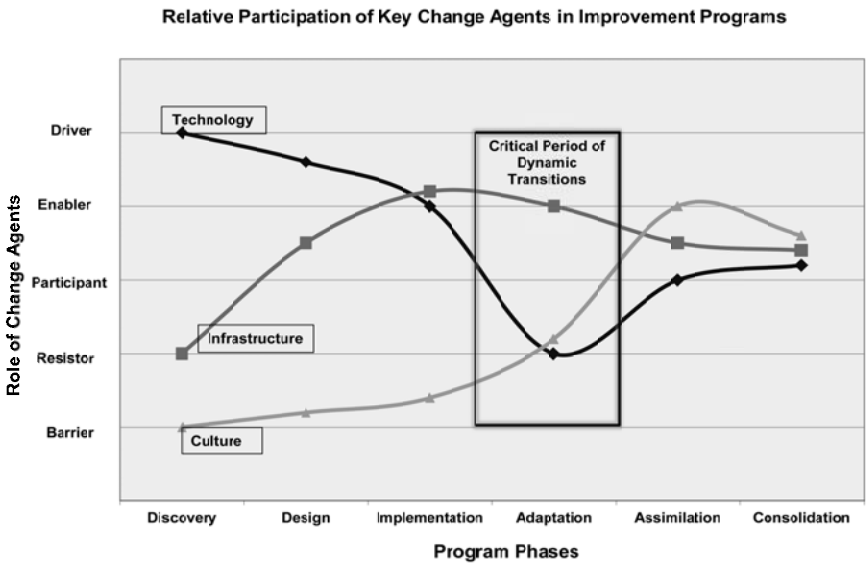
Design. Once there is a decision to do something, a task force takes on the job of designing the program. At this stage, they consider the available technology (high level of emphasis), the changes needed in the infrastructure (some consideration), and the possibilities of culture change (often only a brief look and a "we'll get back to that"). Ironically, often the culture stage can make or break the success of a program. Firm resistance can cause programs to derail, even if there is some apparent good in the program implementation. Consequently, any program introduction should include a subsequent intervention in changing the culture of the organization. Kurt Lewin was one of the first social scientists to realize that the process of change required an unfreezing of social and thought patterns in order for change to be successful (Lewin, 1951). Often, it is a matter of reminding employees that change is necessary, even though it may be painful in the short-run.

Implementation. At this stage, the fanfare and expectations of the program may begin to wane as the reality of the hard work ahead settles into the minds of organizational members. Nonetheless, management should gear itself for this loss of enthusiasm, and expect it as a normal part of the change process. Changing the culture of the organization so that employees will be more future-oriented is necessary.

Adaptation. In this phase, it may become necessary to make mid-course adaptations of the improvement program to meet the specific needs of the organization. Such changes may not have been anticipated originally, but now must be considered if the program is to succeed. Again, affected employees need to be reminded that such mid-course changes are a normal and necessary phase of the implementation process.

Assimilation. Most programs will have a finite life. At some point, the elements of the program that succeeded will be assimilated into the normal way of conducting business. When a program reaches this stage, most of the rough edges have been smoothed and everyone involved appreciates its benefits and limitations.

Consolidation. After the main elements of a program are assimilated into the normal operations of a business, there is a need for a period in which the company operates in a stable and effective way. However, such periods of equilibrium are usually only temporary. In fact, with all of the change that organizations must endure, the normal course of events is to see organizations move in and out of equilibrium. Some note that organizations seeking to operate at a comfortable equilibrium may actually be in danger of failing in the long run (Pascale, 1999; Singh & Singh, 2002). Ready or not, managers and employees must begin to prepare for the next new idea.



Source: Adapted from Crandall and Crandall (2008).

Figure 15.3. Alignment of change agents.

Alignment of Change Agents

Management improvement programs go through several stages. What roles do change agents play during these program phases? At this point, we propose the scenario shown in Figure 15.3.

Discovery. In this initial stage, technology is often the driver. At best, the infrastructure is an unprepared resistor, and the organizational culture is a barrier because of its inherent resistance to change.

Design. Technology continues to lead the change process, although some of its limitations may begin to appear. The infrastructure is adapted to facilitate the changes brought on by technology, and organizational culture begins to move to a more receptive position, albeit slowly.

Implementation. In this phase, both technology and infrastructure must be enablers to achieve momentum. Organizational culture will continue to offer diminishing resistance.

Adaptation. This phase is critical because it reflects the period where changes begin to gel or set within the organization. Even though some technology limitations or deficiencies may require correction or modification, the new infrastructure will serve to compensate for these limitations.

The organizational culture will begin to move toward becoming a more active participant in supporting the change process.

Assimilation. In this phase, the implementation process in terms of technology and infrastructure is now complete. The technology limitations have been corrected or enhanced; the infrastructure settles into its new configuration, and the organizational culture serves to endorse the changes that have occurred.

Consolidation. Technology, infrastructure, and organizational culture have aligned themselves as collaborative participants in moving ahead with the change.

Role of Change Agents

Change Agent 1. Technology is the driver of most improvement programs. It initiates the idea, enables the program to be implemented, becomes a restrictor as the need for modified or improved technology becomes necessary, and finally becomes a participant at the end of the program's life.

Change Agent 2. Infrastructure is rarely a driver of change. It is somewhat a restrictor in the early program stages, becomes a participant early and perhaps even an enabler when it gets ahead of the program needs, then settles back into a comfortable role as participant at the end of the program.

Change Agent 3. Culture is usually a barrier, or at least a restrictor, in the early stages of an improvement program. People are the heart of a company's culture and people resist change. Over time, the people can adapt, the culture can change and become a participant in the program. In fact, under good conditions, the culture may play a key role in assimilating the improvement program into the normal practices of the business. Most organizations should probably begin earlier to adapt the culture to the idea of change.

Conclusion

Most companies find they need to implement management improvement programs, either because they have to or because they are able to. For the program to achieve their objectives, the company must align their principal change agents of technology, infrastructure and culture. A management improvement program will have only limited success until all of the change agents are aligned as participants in the implementation process.

To return to our example of tic-tac-toe, we see that, if we are able to manage "tic" (technology, infrastructure, and culture) as shown in Figure 15.3, we can make the case that we have achieved "tac" (togetherness, alignment, and consistency), all desired elements of a successful management improvement program. Then, if we extend the analogy further, tic, when combined with tac, leads to "toe" (total organizational effectiveness).

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CHAPTER 16

FUTURE OF MANAGEMENT PROGRAMS

What is the future for management programs? Ideally, all of the workable components of the various management programs will be assimilated into the normal operations of a business. All of the programs, regardless of the initial stimulus, become part of a master program containing all of the desired objectives. Once integrated into a single program, the elements can then be absorbed as part of the ongoing operations of the business. Figure 16.1 shows the convergence of all of the programs discussed in previous chapters into one master management program. While this is unlikely, it does suggest the need for multiple initiatives in developing a fully effective organization.

MANAGEMENT FOR THE TWENTY-FIRST CENTURY

As changes take place in society, changes also occur in the various key roles which individuals in society play. One rapidly changing role is that of the contemporary manager, especially the operations manager who must deal with employees on a day-to-day basis. Many of the routine tasks which were formally managerial tasks have been computerized. Examples of these tasks include the scheduling of employees and purchasing supplies and raw materials. Other tasks have been delegated to empowered employees and self-directed work teams. The time needed to gather data to compile in reports has been shortened, as well as the task of interpret-

How Management Programs Can Improve Performance: Selecting and Implementing the Best Program for Your Organization, pp. 569–572
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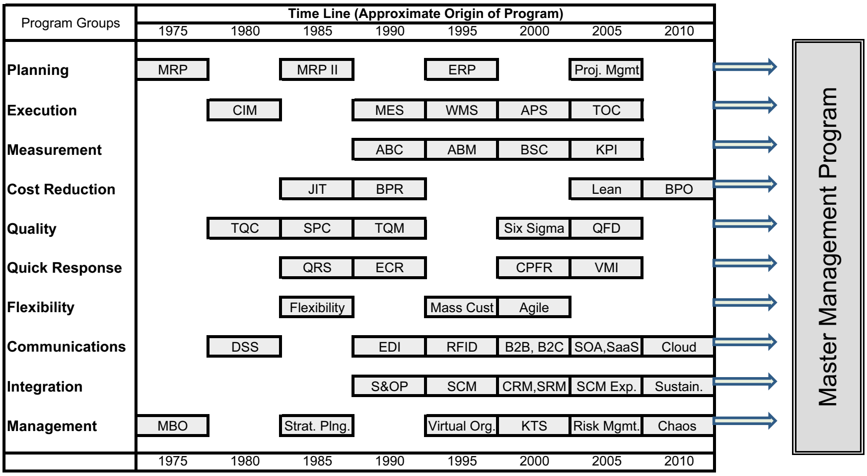

Figure 16.1. Management programs converge into one master program.

ing these reports, which are now often accompanied by notices of key variances that are being violated. (An easy example of this type of report is when your doctor hands you the printed results of your lab results. Cholesterol levels and other key items are "flagged" so you can easily make sense of the results). Relieved of the task of accumulating and interpreting this information, managers must effectively communicate the findings to their employees. This change means that managers must be more highly skilled in interpersonal communications and human relations to perform their roles effectively.

Just as business and management have undergone change, so too have the employees managers lead. Many of these workers have come to expect and demand much more out of their jobs and life in general. For instance, there is more emphasis on non-monetary rewards, and employees are looking increasingly toward their work as a source of fulfilling their needs for self-esteem, accomplishment, challenge and involvement. That is why top-performing companies organize to meet the needs of their people, and not just serve as a place to "work".

Organizing around the needs of people is not as easy as it sounds. It means going against the traditions of what managers do. Instead of giving orders and gathering and analyzing information (managing), managers must set direction and provide resources and encouragement to their employees (leading). It also means aligning the systems, structure, and culture so that the needs of employees are linked with the needs of the

Table 16.1. Future Program Emphases

Aspect of the Program	*Possible Future Emphases*
Paradigm	• Mass customization • Virtual corporation • The Learning Organization
Area of focus	• Manufacturing core competency (outsourcing) • Strategic and collaborative alliances (trust) • Design for adaptability (equipment/employee interface)
Global issues	• Ethics/values equilibrium • Environmental equilibrium • Social equilibrium

business. The business environment is simultaneously faced with the challenges posed by customer service, total quality, continuous improvement, re-engineering, and assorted other hot topics of the month. As a result, many top-performing companies are turning to work teams as the way to link their employees' needs with company needs.

Why teams? Work teams provide the opportunity for employees to get involved in the production processes on a more comprehensive level. In addition, teams can draw on a broader mix of skills, experience, and knowhow than any one person could offer. You do not have to look far to find proof of the stunning success of teams within corporations. Motorola used teams to produce the world's smallest and highest quality cellular phones. Ford relied on them to create its popular Taurus model. 3M credits work teams as the source of its incredible stream of innovations (Crandall & Crandall, 2014). Although the team approach to achieving results started primarily in the manufacturing sector, they are now becoming more common in service organizations as well.

Would the master program shown in Figure 16.1 end the need for management programs? Probably not. There always seems to be a need to consider some new technique or concept. Therefore, we need to expect that we will always have new management programs to consider. Table 16.1 lists a few of the possibilities for the future.

This book has been designed to help the reader find the right management program for her/his organization. We hope you have found it.

ACKNOWLEDGMENT

This chapter has been adapted from Crandall, R. E., and Crandall, W. R. (2014).

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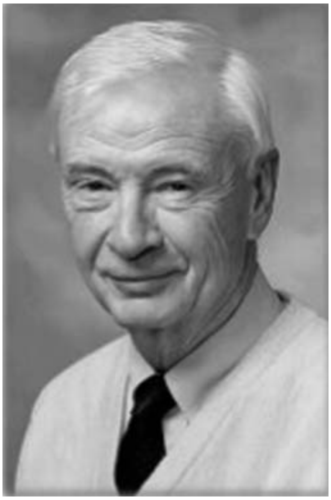
ABOUT THE AUTHORS



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All organizations operate in an environment that is rapidly changing. To be successful, the organization must also change. The question is what to change and how. This book will describe in some detail a number of management programs, many of which are known by their three-letter acronyms, such as Just-in-Time (JIT) or Service-Oriented Architecture (SOA). A management program is designed to improve an organization's effectiveness and efficiency. However, there are so many management programs it is often difficult for managers to decide which one would be most appropriate for their operation. This book will describe an array of management programs and group them to indicate their primary purpose. The book will also outline a process that will enable managers to select the most appropriate management program to meet their immediate and long-term needs.

Implementing a management program is no small task. It can be expensive, time-consuming, and disruptive of normal operations; therefore, the choice of the management program requires careful selection and implementation. Care must be taken to increase the likelihood of successfully implementing new ventures in all types of organizations—business, nonprofit, and governmental agencies. Many ventures fail, or achieve limited success, not because the idea isn't good but because the organization has not adequately prepared its internal capabilities to meet the environmental conditions in which it operates.

IAP–Information Age Publishing
P.O. Box 79049
Charlotte, NC 28271-7047
WWW.INFOAGEPUB.COM

ISBN 978-1-62396-981-3
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