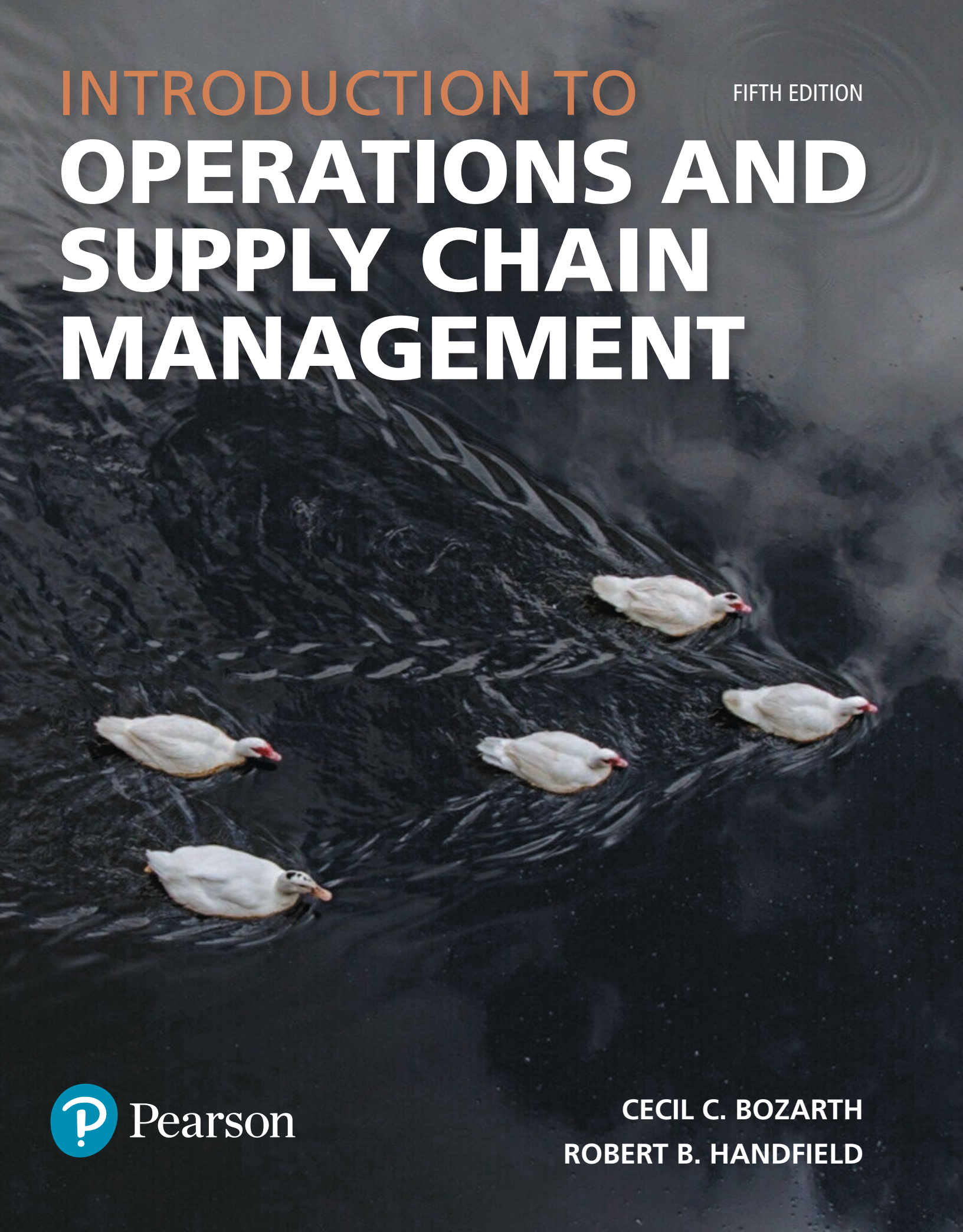
INTRODUCTION TO OPERATIONS AND SUPPLY CHAIN MANAGEMENT

FIFTH EDITION



Pearson

CECIL C. BOZARTH
ROBERT B. HANDFIELD

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North Carolina State University

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To Andrea, James, and Philip

C.B.

To Sandi, Simone, and Luc

R.H.

ABOUT THE AUTHORS

Cecil Bozarth is Professor of Operations and Supply Chain Management at the Poole College of Management at N.C. State University, where he has received awards for teaching excellence at both the undergraduate and graduate levels. He is a former chair of the Operations Management Division of the Academy of Management, and in 1999 was recognized by APICS as a subject matter expert (SME) in the area of supply chain management. His particular areas of interest are operations and supply chain strategy and supply chain information systems. Cecil's consulting experience cuts across a wide range of industries, including such companies as BlueCross BlueShield of North Carolina, Daimler-Benz, John Deere, Duke Energy, Eisai, Ford Motor Company, GKN, IBM, GlaxoSmithKline, Milliken, Patheon, Sonoco, and others. For thirteen years, Cecil was an associate editor for the *Journal of Operations Management*; he now serves on the journal's editorial advisory board. Cecil has also served as a guest editor for the *Academy of Management Journal,* as well as the *Journal of Operations Management*.

Robert Handfield is the Bank of America Professor and a Distinguished University Professor at N.C. State University. Handfield has consulted with over 25 Fortune 500 companies, including Biogen Idec, Caterpillar, John Deere, GlaxoSmithKline, Boston Scientific, Delphi, Chevron, British Petroleum, Chevron Phillips, Bank of America, Sensata, Honda of America, KPMG, Conoco Phillips, Federal Express, SAP, and others, and is a world-renowned expert in the areas of purchasing and logistics. Rob is the former editor-in-chief of the *Journal of Operations Management* and has written several books on SCM topics, including *Introduction to Supply Chain Management* (Prentice Hall, with Ernest L. Nichols; translated into Japanese, Korean, Chinese, and Indonesian), *Supply Chain Redesign* (Prentice Hall Financial Times), and *Purchasing and Supply Chain Management,* 5th edition (South-Western College Publishing, with Robert M. Monczka, Larry C. Giunipero, and James L. Patterson).

BRIEF CONTENTS

CONTENTS

PREFACE

When we set out to write the first edition of this book, we wanted to create an introductory text that provides an integrated and comprehensive treatment of both operations *and* supply chain management. That goal has remained the same through this, our fifth, edition.

NEW TO THIS EDITION


PROFESSIONAL PROFILE

MANDY ALTHOFF, METLIFE

MetLife is a well-respected financial services company that provides life insurance, annuities, employee benefits, and asset management services. Whenever MetLife issues an insurance policy, it takes on some financial risk in exchange for the premiums paid by the customer. Sound business practice and regulatory requirements dictate that MetLife keep enough cash reserves to pay off expected claims by the customers. In some instances, it makes good business sense for MetLife to outsource bundles of existing policies to another insurance company who "reinsures" the policies and takes the financial risk, while MetLife, in some cases, continues to provide service support to the customers.

Reaching an outsourcing agreement that is a win-win-win for MetLife, the reinsurer, and the final customer is a complicated task. While actuaries and underwriters perform much of the financial analysis, someone has to help manage the actual negotiation process (see Chapter 7). Enter Mandy Althoff, a Senior Sourcing Consultant at MetLife. As Mandy puts it, "The idea of having someone from sourcing involved in helping arrange these outsourcing agreements is relatively new—these agreements used to be purely finance driven." Mandy continues: "The business leadership team has been open to my creative approach to negotiation, allowing me a unique seat at the table. It all goes back to my undergraduate sourcing class."


PROFESSIONAL PROFILE

DWIGHT HENDRICKSON, CATERPILLAR

Throughout this book, we have made the point that supply chains cover everything from sourcing-to-producing-to-delivering the final product or service. Furthermore, supply chain management takes place at the strategic planning level, looking years into the future, down to the execution of day-to-day activities.

In over 20 years at Caterpillar, Dwight Hendrickson has experienced all of this firsthand. He has been a commercial purchasing analyst and a lead buyer; a general operations supervisor and certified Six Sigma black belt; and a logistics manager and product program manager. In fact, Dwight's experience is so comprehensive that outside professional organizations regularly look to him for his expertise and leadership. He currently serves on the North Carolina District Export Council (NCDEC), which is made up of professionals who act as consultants to small- and medium-sized businesses that want to export products into markets outside of the United States.

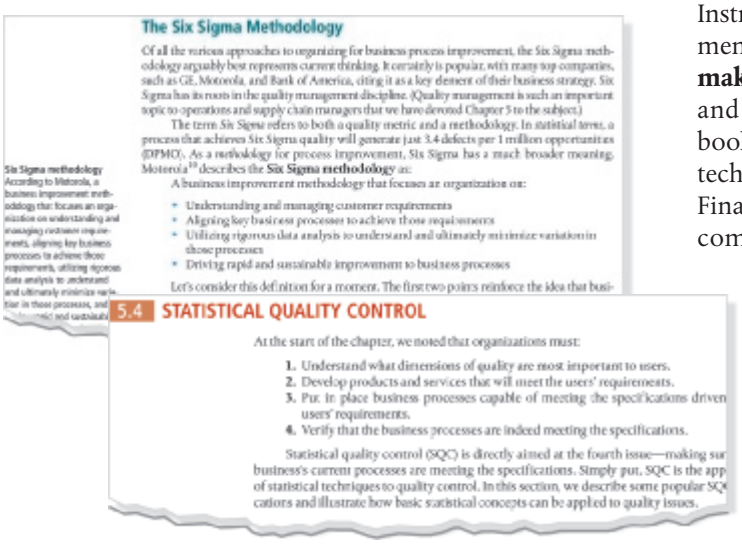
be like? Since the demand for building construction products is tightly tied to the overall health of the world economy and other geopolitical factors, Dwight has to make sure Caterpillar is ready to increase volumes dramatically when the economy is strong and scale down activities

With this new edition, we have continued our strategy of providing detailed coverage of important SCM topics while still maintaining a trim, integrated book. One of the most notable changes is the **professional profiles** found in selected chapters. These half-page profiles focus on individuals working in the operations and supply chain area—their company and industry, experiences and responsibilities, and their advice to others entering the field. These professional profiles are positioned to coincide with the relevant chapter topics so that readers can make the connection between what we are talking about in the book and how this plays out in practice.

We also added a section in Chapter 1 discussing the various employability skills that students can develop by studying the course and incorporating the learnings from this book into their daily lives. We have also updated Chapter 1's discussion of long-term trends to include the concepts of agility.

Chapter 3 now includes a discussion of 3D printing, also known as additive manufacturing. Long used in prototyping new products, 3D printing promises to change the volume/variety trade-offs for many manufactured items. Last, we have updated the opening case study in many of the chapters to reflect the changing business conditions and challenges facing operations and supply chain managers.

SOLVING TEACHING AND LEARNING CHALLENGES


The Six Sigma Methodology

Of all the various approaches to organizing for business process improvement, the Six Sigma methodology arguably best represents current thinking. It certainly is popular, with many top companies, such as GE, Motorola, and Bank of America, citing it as a key element of their business strategy. Six Sigma has its roots in the quality management discipline. (Quality management is such an important topic to operations and supply chain managers that we have devoted Chapter 5 to the subject.)

The term *Six Sigma* refers to both a quality metric and a methodology. In statistical terms, a process that achieves Six Sigma quality will generate just 3.4 defects per 1 million opportunities (DPMO). As a methodology for process improvement, Six Sigma has a much broader meaning. Motorola[10] describes the **Six Sigma methodology** as:

A business improvement methodology that focuses an organization on:

- Understanding and managing customer requirements
- Aligning key business processes to achieve those requirements
- Utilizing rigorous data analysis to understand and ultimately minimize variation in those processes
- Driving rapid and sustainable improvement to business processes

Let's consider this definition for a moment. The first two points reinforce the idea that busi-

Six Sigma methodology
According to Motorola, a business improvement methodology that focuses an organization on understanding and managing customer requirements, aligning key business processes to achieve those requirements, utilizing rigorous data analysis to understand and ultimately minimize variation in those processes, and

5.4 STATISTICAL QUALITY CONTROL

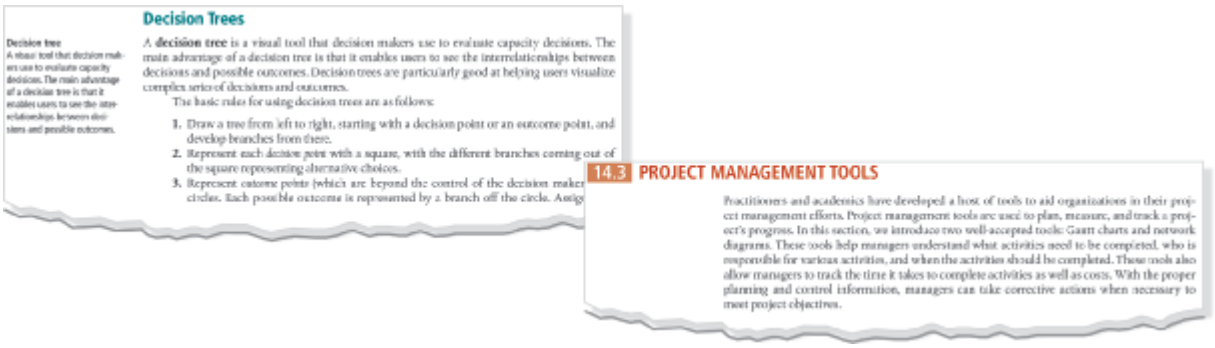
At the start of the chapter, we noted that organizations must:

1. Understand what dimensions of quality are most important to users.
2. Develop products and services that will meet the users' requirements.
3. Put in place business processes capable of meeting the specifications driven by users' requirements.
4. Verify that the business processes are indeed meeting the specifications.

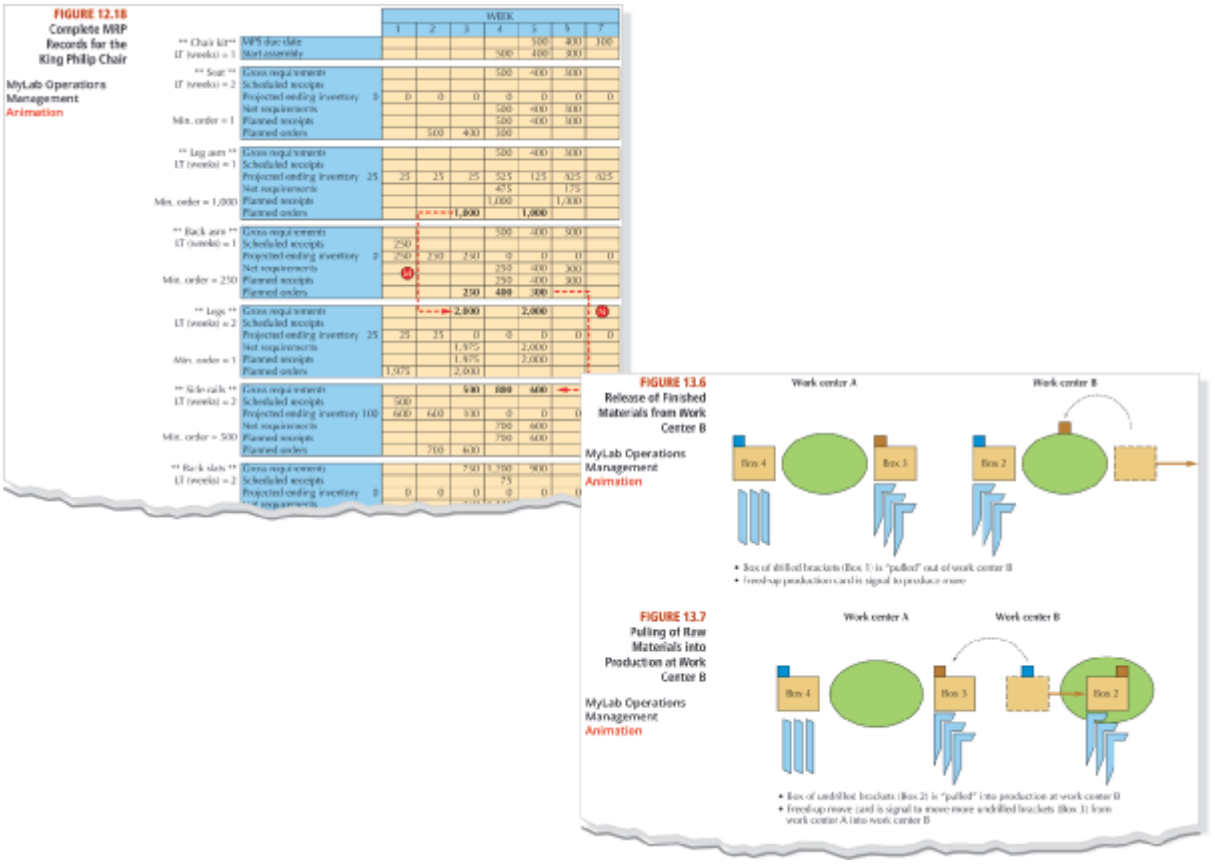
Statistical quality control (SQC) is directly aimed at the fourth issue—making sure business's current processes are meeting the specifications. Simply put, SQC is the application of statistical techniques to quality control. In this section, we describe some popular SQC applications and illustrate how basic statistical concepts can be applied to quality issues.

Instructors teaching operations and supply chain management face several challenges. The first is helping students **make the connection** between the needs of the business and the tools and techniques operations covered in the book. A second challenge is deciding exactly *what* tools and techniques to cover, especially in an introductory course. Finally, some of the more quantitative tools can be quite complex, requiring a variety of learning approaches to help students master them. This book addresses these challenges in the following manner:

- The book contains **comprehensive coverage** of the tools and techniques in the traditional OM areas (quality, capacity, queuing, forecasting, inventory, planning and control, and project management), *as well as* the purchasing and logistics areas.



- Tools and techniques are always introduced **within the context** of the OM and SCM issues at hand. For example, we show how sales and operations planning (Chapter 10) can be used to coordinate activity *across* supply chain partners, as well as in its traditional role as an intra-firm planning approach.
- In addition to the extensive use of solved problems, students are shown how tools and techniques can be applied using **Microsoft Excel spreadsheets.** Learning is reinforced through homework problems that provide the students with a template and hints for checking their answers.
- An **Enhanced eText,** available in **MyLab Operations Management,** gives instructors and students the ability to highlight the text, bookmark, search the glossary, and take notes. More importantly, the eText provides a new way of learning that is particularly useful to today's students. Students are able to review animations of figures, indicated by **MyLab Operations Management** Animation, and videos of solved problems available on MyLab Operations Management with a simple click of an icon. Visit www.pearson.com/mylab/operations-management for more information.



Tools and Techniques Integrated Throughout

TOOLS AND TECHNIQUES	SOLVED EXAMPLES	HOMEWORK PROBLEMS	EXCEL EXAMPLES/ PROBLEMS
Chapter 2: Operations and Supply Chain Strategies			
Value index	✓	✓	✓
Chapter 3: Process Choice and Layout Decisions in Manufacturing and Services			
Service blueprinting	✓		
Line balancing	✓	✓	
Assigning department locations	✓	✓	
Chapter 4: Business Processes			
Performance measures (productivity, efficiency, cycle time, percent value-added time)	✓	✓	
Process mapping	✓	✓	
Six Sigma methodology and DMAIC process	✓		
Continuous improvement tools (root cause analysis, scatter plots, check sheets, Pareto charts)	✓	✓	
Cause-and-effect diagrams	✓		
Chapter 5: Managing Quality			
Process capability ratio	✓	✓	
Process capability index	✓	✓	
Six Sigma quality	✓	✓	
X and *R* charts	✓	✓	✓
p charts	✓	✓	✓
Acceptance sampling	✓		
Chapter 6: Managing Capacity			
Expected value analysis	✓	✓	✓
Decision trees	✓	✓	
Break-even analysis	✓	✓	✓
Indifference point	✓	✓	✓
Learning curves	✓	✓	
Theory of constraints	✓		
Waiting lines (queuing analysis)	✓	✓	
Little's Law	✓	✓	
Simulation analysis	✓		✓
Chapter 7: Supply Management			
Total cost analysis	✓	✓	
Weighted-point evaluation system	✓	✓	✓
Profit leverage	✓	✓	
Spend analysis	✓	✓	
Chapter 8: Logistics			
Shipment consolidation	✓	✓	✓
Perfect order calculation	✓	✓	
Landed costs	✓	✓	
Weighted center of gravity model	✓	✓	✓
Optimization modeling (assignment problem using Excel Solver function)	✓	✓	✓
Chapter 9: Forecasting			
Moving average model	✓	✓	✓
Exponential smoothing model	✓	✓	✓
Adjusted exponential smoothing model	✓	✓	✓
Linear regression	✓	✓	✓
Seasonal adjustments	✓	✓	✓
Multiple regression	✓	✓	✓

(*Continued*)

TOOLS AND TECHNIQUES	SOLVED EXAMPLES	HOMEWORK PROBLEMS	EXCEL EXAMPLES/ PROBLEMS
MAPE, MAD, MFE, and tracking signal	✓	✓	✓
Chapter 10: Sales and Operations Planning (Aggregate Planning)			
Top-down sales and operations planning	✓	✓	✓
Bottom-up sales and operations planning	✓	✓	
Cash flow analysis	✓	✓	
Load profiles	✓	✓	
Optimization modeling (top-down sales and operations planning using Excel Solver function)	✓	✓	✓
Chapter 11: Managing Inventory throughout the Supply Chain			
Periodic review systems	✓	✓	
Economic order quantity	✓	✓	✓
Reorder points and safety stock	✓	✓	✓
Quantity discounts	✓	✓	
Single-period inventory systems (newsboy problem)	✓	✓	
Pooling safety stock	✓	✓	✓
Chapter 12: Managing Production across the Supply Chain			
Master scheduling	✓	✓	
Material requirements planning (MRP)	✓	✓	
Job sequencing rules	✓	✓	
Distribution requirements planning (DRP)	✓	✓	
Chapter 13: JIT/Lean Production			
Kanban sizing	✓	✓	
Linking MRP and kanban	✓	✓	
Chapter 14: Managing Projects			
Gantt charts	✓	✓	
Activity on node (AON) diagrams and critical path method (CPM)	✓	✓	Microsoft Project example
Project crashing	✓	✓	
Chapter 15: Developing Products and Services			
Quality function deployment (QFD)	✓		

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DEVELOPING EMPLOYABILITY SKILLS

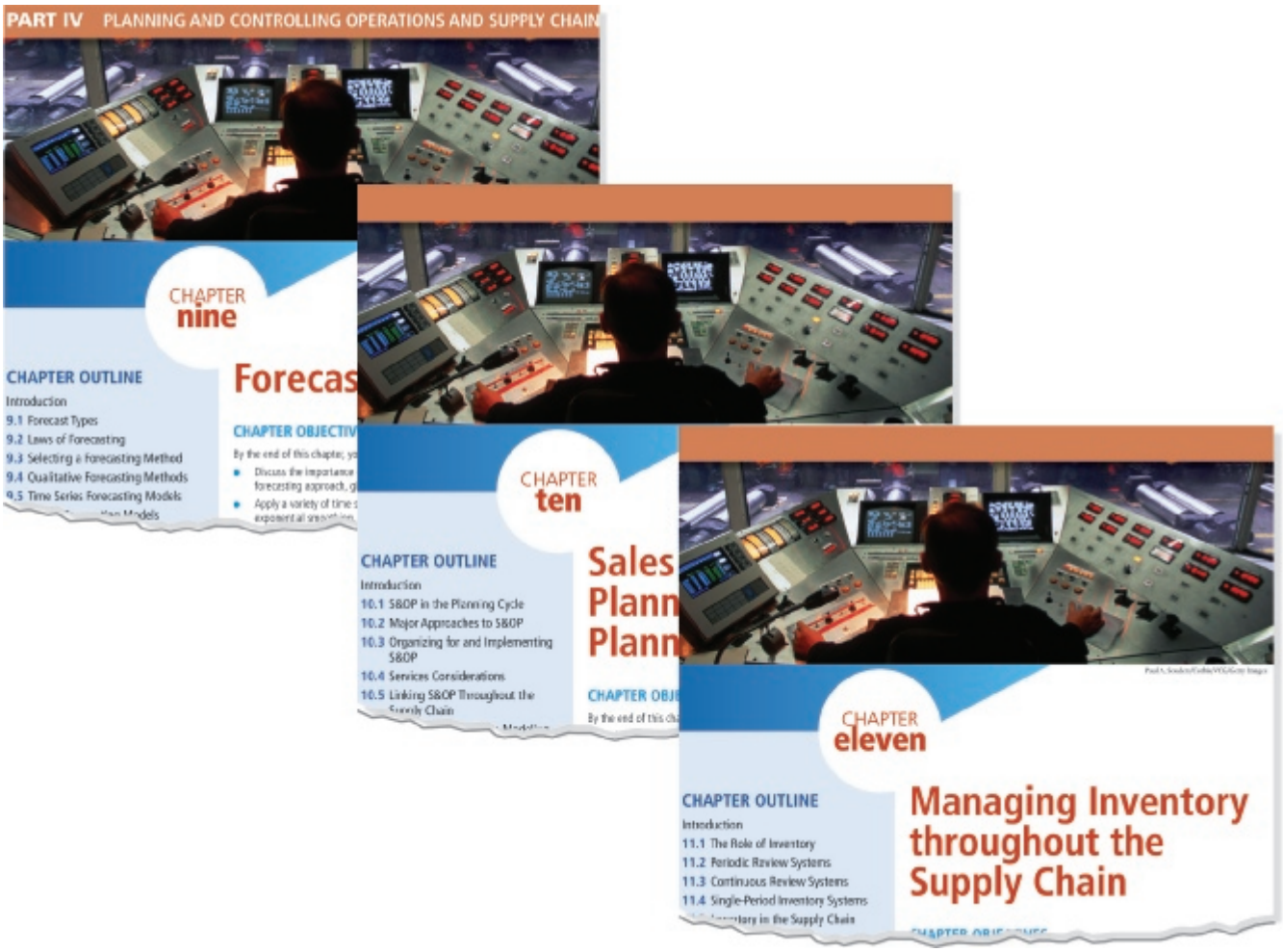
This book covers many skills that hiring managers identify as important to success in a variety of business settings, including small and large firms, nonprofit organizations, and public service.

Critical Thinking

Critical thinking involves purposeful and goal-directed thinking used to define and solve problems, make decisions, or form judgments related to a particular situation or set of circumstances. This book is filled with dozens of useful frameworks that managers regularly use to support problem solving, including the Six Sigma methodology (Chapter 4), decision tree analysis (Chapter 6), sourcing portfolio analysis (Chapter 7), and project management tools (Chapter 14). It is not an exaggeration to say that critical thinking and fact-based decision making are built into the DNA of the operations and supply chain discipline.

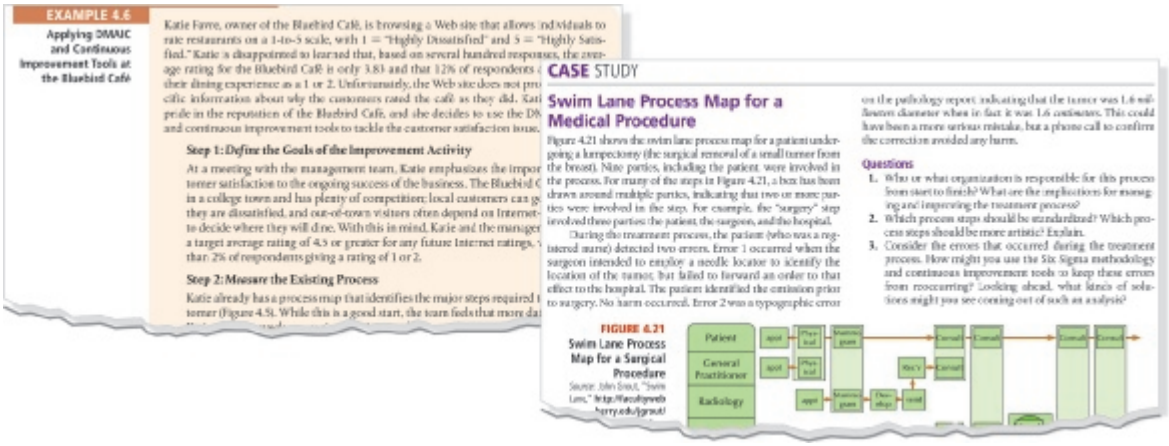
Collaboration

Many key operations and supply chain activities require close collaboration with participants from other areas, such as marketing, engineering, and finance. Throughout this book, we will emphasize the importance of cross-functional collaboration as well as collaboration with outside supply chain partners. Forecasting (Chapter 9) and inventory management (Chapter 11) are just two areas in which collaboration is essential for the process to work. Chapter 10, in fact, is devoted to sales and operations planning, an approach to planning that depends entirely on collaboration and negotiation between operations, marketing, finance, and human resources in order to succeed.



Knowledge Application and Analysis

Knowledge application and analysis is defined as the ability to learn a concept and then apply that knowledge in another setting to achieve a higher level of understanding. Put another way, understanding is more than just memorizing formulas and cranking out answers. As such, this book seeks to move students "beyond the formulas" by illustrating how the concepts can be applied in a wide range of settings, using both extended examples and in-chapter case studies.


EXAMPLE 4.6

Applying DMAIC and Continuous Improvement Tools at the Bluebird Café

CASE STUDY

Swim Lane Process Map for a Medical Procedure

FIGURE 4.21 Swim Lane Process Map for a Surgical Procedure

Information Technology Application and Computing Skills

Finally, information technology application and computing skills are defined as the ability to select and use appropriate technology to accomplish a given task. This book covers this skill set in a couple different ways. First, the book includes numerous, detailed examples of how Microsoft Excel can be used to carry out the various calculations covered in the text. Second, we have devoted the Chapter 12 supplement to understanding supply chain information system needs and reviewing recent trends in the area.

TABLE OF CONTENTS OVERVIEW

I. Creating Value through Operations and Supply Chains

Ch. 1: Introduction to Operations and Supply Chain Management	Introduces basic concepts and definitions that lay the groundwork for future chapters
Ch. 2: Operations and Supply Chain Strategies	Discusses operations and supply chain strategies, including what they are, how they support the organization's overall strategy, and how they help a firm provide value to the customer

II. Establishing the Operations Environment

Ch. 3: Process Choice and Layout Decisions in Manufacturing and Services	Describes the manufacturing and service processes that firms put in place to provide products or services
Ch. 4: Business Processes	Introduces the topic of business processes, which can be thought of as the "molecules" that make up all operations and supply chain flows
Ch. 5: Managing Quality	Provides an overview of the different perspectives on quality, as well as some of the tools and techniques companies use to improve and monitor quality levels
Ch. 6: Managing Capacity	Discusses capacity and introduces several tools that managers use to evaluate capacity choices, including expected value analysis, waiting line theory, and Little's Law

III. Establishing Supply Chain Linkages

Ch. 7: Supply Management	Describes the broad set of activities carried out by organizations to analyze sourcing opportunities, develop sourcing strategies, select suppliers, and carry out all the activities required to procure goods and services
Ch. 8: Logistics	Discusses the physical flow of goods throughout the supply chain and covers such areas as transportation, warehousing, and logistics decision models

IV. Planning and Controlling Operations and Supply Chains

Ch. 9: Forecasting	Discusses the different types of forecasts firms use, and covers the most common quantitative forecasting methods
Ch. 10: Sales and Operations Planning (Aggregate Planning)	Describes S&OP process and major approaches to developing plans. Additional topics include cash flow analysis and linking S&OP throughout the supply chain
Ch. 11: Managing Inventory throughout the Supply Chain	Discusses the critical role of inventory, and tools and techniques for managing it
Ch. 12: Managing Production across the Supply Chain	Introduces some of the systems manufacturers use to manage production and to coordinate these activities with their supply chain partners
Ch. 13: JIT/Lean Production	Introduces the just-in-time (JIT)/Lean philosophy, and provides coverage of kanban production techniques

V. Project Management and Product/Service Development

Ch. 14: Managing Projects	Describes how organizations manage projects, and covers common project management tools, including network-based models
Ch. 15: Developing Products and Services	Addresses the product and service development process, with an emphasis on how these decisions directly affect choices in operations and supply chain management

INSTRUCTOR TEACHING RESOURCES

This program comes with the following teaching resources.

SUPPLEMENTS AVAILABLE TO INSTRUCTORS AT WWW.PEARSONHIGHERED.COM/BOZARTH	FEATURES OF THE SUPPLEMENT
Instructor's Solutions Manual, authored by Geoff Willis from UCO College of Business	• Detailed solutions for all end-of-chapter Discussion Questions, Problems, and Case Study questions • Solutions of the Excel problems available on the Data Download page
Test Bank, authored by Geoff Willis from UCO College of Business	More than 1,500 multiple-choice, true/false, short-answer, and graphing questions with these annotations: • Difficulty level (1 for straight recall, 2 for some analysis, 3 for complex analysis) • Type (Multiple-choice, true/false, short-answer, essay) • Keywords (The term or concept the question supports) • Learning outcome • AACSB learning standard (Written and Oral Communication; Ethical Understanding and Reasoning; Analytical Thinking; Information Technology; Interpersonal Relations and Teamwork; Diverse and Multicultural Work; Reflective Thinking; Application of Knowledge)

(*Continued*)

SUPPLEMENTS AVAILABLE TO INSTRUCTORS AT WWW.PEARSONHIGHERED.COM/BOZARTH	FEATURES OF THE SUPPLEMENT
Computerized TestGen	TestGen allows instructors to: • Customize, save, and generate classroom tests • Edit, add, or delete questions from the Test Item Files • Analyze test results • Organize a database of tests and student results
PowerPoints, authored by Dr. Kathryn A. Marley from Duquesne University	Slides include key Excel figures, graphs, tables, and equations in the textbook PowerPoints meet accessibility standards for students with disabilities. Features include, but not limited to: • Keyboard and Screen Reader access • Alternative text for images • High color contrast between background and foreground colors
Excel Problems	Instructors can create different homework problems for different class sections and even different students. This feature is ideal for instructors teaching large sections of an introductory operations/supply chain course. With these homework problems, professors have an extra measure to guard against plagiarism in homework assignments. Here's how it works: **1.** Students go to the Multimedia Library in MyLab Operations Management or to the Data Download page at www.pearsonhighered.com/bozarth and open an Excel spreadsheet listed under the chapter of interest. **2.** Students type their name and a four-digit number chosen by the instructor into the spreadsheet. The four-digit number creates new parameters for the problem. **3.** Students print out their customized homework sets and solve the problems. **4.** The instructor uses an Excel-based key that uses the same four-digit number to generate the correct answers.

If assistance is needed, our dedicated technical support team is ready to help with the media supplements that accompany this text. Visit **support.pearson.com/getsupport** for answers to frequently asked questions and toll-free user support phone numbers.

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CHAPTER
one

Introduction to Operations and Supply Chain Management

CHAPTER OUTLINE

CHAPTER OBJECTIVES

By the end of this chapter, you will be able to:

- Describe what the operations function is and why it is critical to an organization's survival.
- Describe what a supply chain is and how it relates to a particular organization's operations function.
- Discuss what is meant by operations management and supply chain management.
- Identify some of the major operations and supply chain activities, as well as career opportunities in these areas.
- Make a case for studying *both* operations management and supply chain management.

INTRODUCTION

Let's start with a question: What do the following organizations have in common?

- **Walmart,** which not only is a leading retailer in the United States but also has built a network of world-class suppliers, such as GlaxoSmithKline, Sony, and Mattel
- **FedEx,** a service firm that provides supply chain solutions and transportation services
- **Flex Ltd.,** a contract manufacturer that assembles everything from plug-in electric motorcycles to LCD and touch displays
- **SAP,** the world's largest provider of enterprise resource planning (ERP) software

While these firms may appear to be very different from one another, they have at least one thing in common: a strong commitment to superior operations and supply chain management.

In this chapter, we kick off our study of operations and supply chain management. We begin by examining what operations is all about and how the operations of an individual organization fit within a larger supply chain. We then talk about what it means to *manage* operations and supply chains. As part of this discussion, we will introduce you to the Supply Chain Operations Reference (SCOR) model, which many businesses use to understand and structure their supply chains.

In the second half of the chapter, we discuss several trends in business that have brought operations and supply chain management to the forefront of managerial thinking. We also devote a section to what this all means to you. We discuss career opportunities in the field, highlight some of the major professional organizations that serve operations and supply chain professionals, and look at some of the major activities that operations and supply chain professionals are involved in on a regular basis. We end the chapter by providing a roadmap of this book.

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Operations management and supply chain management cover a wide range of activities, including transportation services, manufacturing operations, retailing, and consulting.

1.1 WHY STUDY OPERATIONS AND SUPPLY CHAIN MANAGEMENT?

So, why should you be interested in operations and supply chain management? There are three simple reasons.

1. ***Every organization must make a product or provide a service that someone values.*** Otherwise, why would the organization exist? Think about it. Manufacturers produce physical goods that are used directly by consumers or other businesses. Transportation companies provide valuable services by moving and storing these goods. Design firms use their expertise to create products or even corporate images for customers. Software firms develop apps that consumers use on their smartphones. The need to provide a valuable product or service holds true for not-for-profit organizations as well. Consider the variety of needs met by government agencies, charities, and religious groups, for example.

   The common thread is that each organization has an operations function, or *operations*, for short. The **operations function** is the collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services. Regardless of what career path you might choose, you will need to know something about your organization's operations function.

   Operations function
   Also called *operations*. The collection of people, technology, and systems within an organization that has primary responsibility for providing the organization's products or services.

   As important as the operations function is to a firm, few organizations can—or even want to—do everything themselves. This leads to our second reason for studying operations and supply chain management.

2. ***Most organizations function as part of larger supply chains.*** A **supply chain** is a network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows. When the primary focus is on physical goods, much of the supply chain activity will revolve around the conversion, storage, and movement of materials and products. In other cases, the focus might be on providing an intangible service. For example, automobile insurance companies like Progressive Insurance depend on cellular phone networks and Internet service providers (ISPs) to support the data flows that allow customers to upload photos of accident damage and receive settlement checks electronically.

   Supply chain
   A network of manufacturers and service providers that work together to create products or services needed by end users. These manufacturers and service providers are linked together through physical flows, information flows, and monetary flows.

   Supply chains link together the operations functions of many different organizations to provide real value to customers. Consider a sporting goods store that sells athletic shoes. Although the store doesn't actually make the shoes, it provides valuable services for its customers—a convenient location and a wide selection of products. Yet, the store is only one link in a much larger supply chain that includes:

   - Plastic and rubber producers that provide raw materials for the shoes.
   - Manufacturers that mold and assemble the shoes.
   - Wholesalers that decide what shoes to buy and when.
   - Transportation firms that move the materials and finished shoes to all parts of the world.
   - Software firms and ISPs that support the information systems that coordinate these physical flows.
   - Financial firms that help distribute funds throughout the supply chain, ensuring that the manufacturers and service firms are rewarded for their efforts.

   So where does this lead us? To our third reason for studying operations and supply chain management—and the premise for this book.

3. ***Organizations must carefully manage their operations and supply chains in order to prosper and, indeed, survive.*** Returning to our example, think about the types of decisions facing a shoe manufacturer. Some fundamental operations decisions that it must make include the following: "How many shoes should we make, and in what styles and sizes?" "What kind of people skills and equipment do we need?" "Should we locate our

Dmitri Ma/Shutterstock

Athletic shoes at a retailer represent the last stage in a supply chain that crosses the globe and involves many different companies.

plants to take advantage of low-cost labor or to minimize shipping cost and time for the finished shoes?"

In addition to these operations issues, the shoe manufacturer faces many decisions with regard to its role in the supply chain: "From whom should we buy our materials—the lower-cost supplier or the higher-quality one?" "Which transportation carriers will we use to ship our shoes?" The right choices can lead to higher profitability and increased market share, while the wrong choices can cost the company dearly—or even put it out of business.

Operations Management

Let's begin our detailed discussion of operations and supply chain management by describing operations a little more fully and explaining what we mean by operations management. As we noted earlier, all organizations must make products or provide services that someone values, and the operations function has the primary responsibility for making sure this happens.

One way to think about operations is as a *transformation process* that takes a set of inputs and transforms them in some way to create outputs—either goods or services—that a customer values (Figure 1.1). Consider a plant that makes wood furniture. Even for a product as simple as a chair, the range of activities that must occur to transform raw lumber into a finished chair can be overwhelming at first. Raw lumber arrives as an input to the plant, perhaps by truck or even train car. The wood is then unloaded and moved onto the plant floor. Planing machines cut the

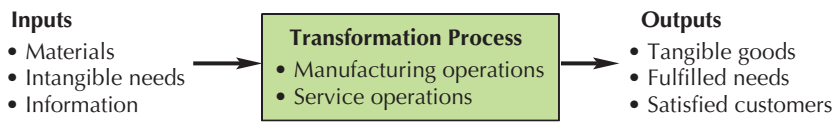

FIGURE 1.1
Viewing Operations as a Transformation Process

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Health care services use highly skilled individuals as well as specialized equipment to provide physiological transformation processes for their patients.

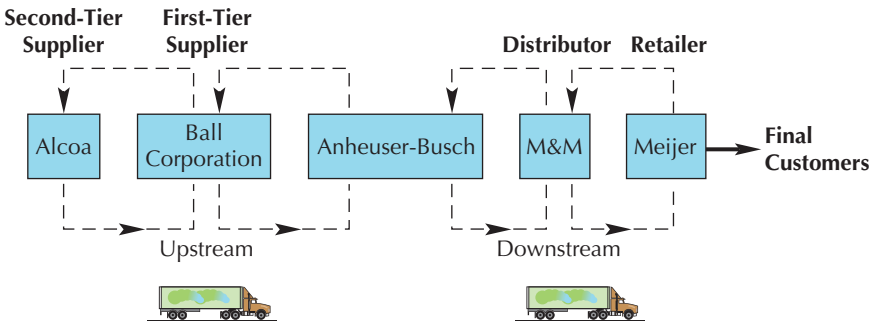
lumber to the right thickness. Lathes shape pieces of wood into legs and back spindles for the chairs. Other machines fabricate wood blanks, shaping them into seats and boring holes for the legs and back spindles.

In addition to the equipment, there are people who run and load the machines, conveyors, and forklifts that move materials around the plant, and there are other people who assemble the chairs. Once the chairs are finished, still more people pack and move the chairs into a finished goods warehouse or onto trucks to be delivered to customers. In the background, supervisors and managers use information systems to plan what activities will take place next.

The operations function can also provide intangible services, as in the case of a law firm. A major input, for example, might be the need for legal advice—hardly something you can put your hands around. The law firm, through the skill and knowledge of its lawyers and other personnel, transforms this input into valuable legal advice, thereby fulfilling the customer's needs. How well the law firm accomplishes this transformation goes a long way in determining its success.

Figure 1.1 makes several other points. First, inputs to operations can come from many places and take many different forms. They can include raw materials, intangible needs, and even information, such as demand forecasts. Also, operations are often highly dependent on the quality and availability of inputs. Consider our furniture plant again. If the lumber delivered to it is of poor quality or arrives late, management might have to shut down production. In contrast, a steady stream of good-quality lumber can ensure high production levels and superior products. Second, nearly all operations activities require coordination with other business functions, including engineering, marketing, and human resources. We will revisit the importance of cross-functional decision making in operations throughout the book. Third, operations management activities are information and decision intensive. You do not have to be able to assemble a product or treat a patient yourself to be a successful operations manager—but you *do* have to make sure the right people and equipment are available to do the job, the right materials arrive when needed, and the product or service is completed on time, at cost, and to specifications!

FIGURE 1.2
A Simplified View of Anheuser-Busch's Supply Chain



Operations management
"The planning, scheduling, and control of the activities that transform inputs into finished goods and services."

Operations management, then, is "the planning, scheduling, and control of the activities that transform inputs into finished goods and services."[1] Operations management decisions can range from long-term, fundamental decisions about what products or services will be offered and what the transformation process will look like to more immediate issues, such as determining the best way to fill a current customer request. Through sound operations management, organizations hope to provide the best value to their customers while making the best use of resources.

Supply Chain Management

Upstream
A term used to describe activities or firms that are positioned *earlier* in the supply chain relative to some other activity or firm of interest. For example, corn harvesting takes place upstream of cereal processing, and cereal processing takes place upstream of cereal packaging.

Downstream
A term used to describe activities or firms that are positioned *later* in the supply chain relative to some other activity or firm of interest. For example, sewing a shirt takes place downstream of weaving the fabric, and weaving the fabric takes place downstream of harvesting the cotton.

First-tier supplier
A supplier that provides products or services directly to a firm.

Second-tier supplier
A supplier that provides products or services to a firm's first-tier supplier.

The traditional view of operations management illustrated in Figure 1.1 still puts most of the emphasis on the activities a particular organization must perform when managing its own operations. But, as important as a company's operations function is, it is not enough for a company to focus on doing the right things within its own four walls. Managers must also understand how the company is linked in with the operations of its suppliers, distributors, and customers—what we refer to as the supply chain.

As we noted earlier, organizations in the supply chain are linked together through physical flows, information flows, and monetary flows. These flows go both up and down the chain. Let's extend our discussion and vocabulary using a product many people are familiar with: a six-pack of beer. Figure 1.2 shows a simplified supply chain for Anheuser-Busch. From Anheuser-Busch's perspective, the firms whose inputs feed into its operations are positioned **upstream,** while those firms who take Anheuser-Busch's products and move them along to the final consumer are positioned **downstream.**

When the typical customer goes to the store to buy a six-pack, he or she probably does not consider all of the steps that must occur beforehand. Take cans, for example. Alcoa extracts the aluminum from the ground and ships it to Ball Corporation, which converts the aluminum into cans for Anheuser-Busch. In the supply chain lexicon, Ball Corporation is a **first-tier supplier** to Anheuser-Busch because it supplies materials directly to the brewer. By the same logic, Alcoa is a **second-tier supplier;** it provides goods to the first-tier supplier.

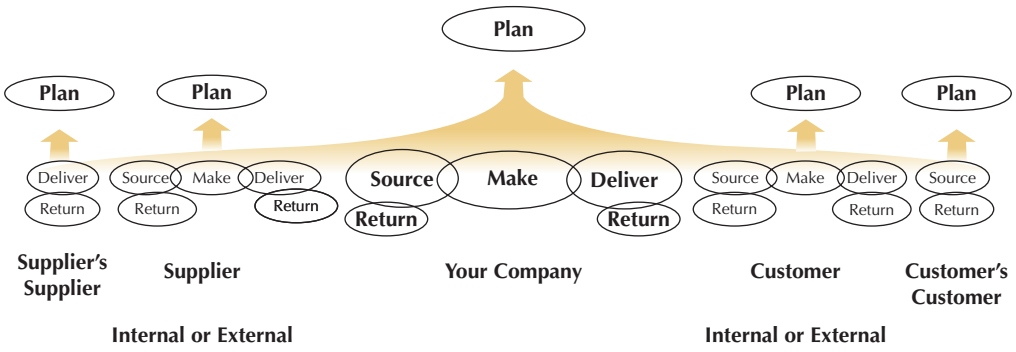
The cans from Ball Corporation are combined with other raw materials, such as cartons, grain, hops, yeast, and water, to produce the packaged beverage. Anheuser-Busch then sells the packaged beverage to M&M, a wholesaler that, in turn, distributes the finished good to Meijer, the retailer. Of course, we cannot forget the role of transportation carriers, which carry the inputs and outputs from one place to the next along the supply chain.

As Figure 1.2 suggests, the flow of goods and information goes both ways. For instance, Ball Corporation might place an order (information) with Alcoa, which, in turn, ships aluminum (product) to Ball. Anheuser-Busch might even return empty pallets or containers to its first-tier suppliers, resulting in a flow of physical goods back *up* the supply chain.

Of course, there are many more participants in the supply chain than the ones shown here; Anheuser-Busch has hundreds of suppliers, and the number of retailers is even higher. We could also diagram the supply chain from the perspective of Alcoa, M&M, or any of the other

[1] J. H. Blackstone, ed., *APICS Dictionary*, 15th ed. (Chicago, IL: APICS, 2016).

FIGURE 1.3
The Supply Chain Operations Reference (SCOR) Model



participants. The point is that most of the participants in a supply chain are both customers and suppliers. Finally, the supply chain must be very efficient, as the final price of the good must cover all of the costs involved plus a profit for each participant in the chain.

While you were reading through the above example, you might have thought to yourself, "Supply chains aren't new"—and you'd be right. Yet most organizations historically performed their activities independently of other firms in the chain, which made for disjointed and often inefficient supply chains. In contrast, **supply chain management** is the *active* management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible.

Supply chain management
The *active* management of supply chain activities and relationships in order to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by a firm or group of firms to develop and run supply chains in the most effective and efficient ways possible.

But what exactly *are* these supply chain activities? To answer this, we turn to the **Supply Chain Operations Reference (SCOR) model.** The SCOR model is a framework that seeks to provide standard descriptions of the processes, relationships, and metrics that define supply chain management.[2] We will explore the SCOR model in more detail in Chapter 4, but for now, Figure 1.3 provides a high-level view of the framework. According to the SCOR model, supply chain management covers five broad areas:

Supply Chain Operations Reference (SCOR) model
A framework developed and supported by the Supply Chain Council that seeks to provide standard descriptions of the processes, relationships, and metrics that define supply chain management.

1. *Planning activities,* which seek to balance demand requirements against resources and communicate these plans to the various participants.
2. *Sourcing activities,* which include identifying, developing, and contracting with suppliers and scheduling the delivery of incoming goods and services.
3. *"Make," or production, activities,* which cover the actual production of a good or service.
4. *Delivery activities,* which include everything from entering customer orders and determining delivery dates to storing and moving goods to their final destination.
5. *Return activities,* which include the activities necessary to return and process defective or excess products or materials.

Finally, notice that Figure 1.3 shows the supply chain management task extending from the company's suppliers' suppliers, all the way to the customers' customers. As you can imagine, coordinating the activities of all these parties is challenging.

To illustrate, let's consider Walmart, one of the earliest proponents of supply chain management.[3] What Walmart was doing in the late 1980s and early 1990s was nothing short of revolutionary. Individual stores sent daily sales information to Walmart's suppliers via satellite. These suppliers then used the information to plan production and ship orders to Walmart's warehouses. Walmart used a dedicated fleet of trucks to ship goods from warehouses to stores in less than 48 hours and to replenish store inventories about twice a week. The result was better customer service (because products were nearly always available), lower production and transportation costs (because suppliers made and shipped only what was

[2]SCOR Framework, **www.apics.org/apics-for-business/products-and-services/apics-scc-frameworks/scor.**
[3]G. Stalk, P. Evans, and L. E. Shulman, "Competing on Capabilities: The New Rules of Corporate Strategy," *Harvard Business Review* 70, no. 2 (March–April 1992): 57–69.

JG Photography/Alamy Stock Photo

Walmart was an early proponent of superior supply chain performance. Other companies have now adopted many of the practices Walmart pioneered in the 1980s.

needed), and better use of retail store space (because stores did not have to hold an excessive amount of inventory).

Walmart has continued to succeed through superior sourcing and delivery, and many of the practices it helped pioneer have taken root throughout the business world. In fact, many retailers now make *multiple* shipments to stores each day, based on *continuous* sales updates. To illustrate how widespread supply chain management thinking has become, consider the example of Panera Bread in the *Supply Chain Connections* feature.

Supply chain management efforts can range from an individual firm taking steps to improve the flow of information between itself and its supply chain partners to a large trade organization looking for ways to standardize transportation and billing practices. In the case of Walmart, a single, very powerful firm took primary responsibility for improving performance across its own supply chain. As an alternative, companies within an industry often form councils or groups to identify and adopt supply chain practices that will benefit all firms in the industry. One such group is the Automotive Industry Action Group (AIAG, **www.aiag.org**), whose members "work collaboratively to streamline industry processes via global standards development & harmonized business practices."[4] The Grocery Manufacturers of America (GMA, **www.gmaonline.org/**) serves a similar function. Other organizations, such as APICS (**www.apics.org/apics-for-business**), seek to improve supply chain performance across many industries.

[4]Automotive Industry Action Group (AIAG), **www.aiag.org/about.**

SUPPLY CHAIN CONNECTIONS

PANERA BREAD: "A LOAF OF BREAD IN EVERY ARM"

If you live in the United States or Canada, there is a good chance that you have either heard of or visited a Panera Bread bakery-cafe. Panera Bread is a specialty food retailer that has built its business on providing consumers with fresh artisan bread products served at strategically located, distinctive bakery-cafes. As of December 2016, Panera Bread had over 2,100 company- and franchise-operated bakery-cafes.[5] Financial results have been equally impressive: for 2015, revenues from $2.68 billion, with an operating profit of over $240 million.[6]

But consider for a moment the upstream supply chain activities that must take place to ensure that these bakery-cafes receive the fresh dough needed to fulfill the company's mission statement, "A loaf of bread in every arm." In the case of Panera Bread, the operations and supply chain team has responded by putting in place a network of 24 fresh dough manufacturing facilities that produce more than 300 million pounds of dough annually. To ensure the freshest product possible, this dough is delivered 7 days a week, 365 days a year, to the bakery-cafes. Panera's operations and supply chain team also controls the distribution system for the retail bakery-cafes and supports the company's baking activities. In effect, the team is responsible for everything that comes through the back doors of Panera Bread bakery-cafes.

Even in this short description, we can see how Panera Bread's supply chain activities cover everything from sourcing to production to delivery. It's a safe bet that Panera Bread's interest in effective supply chain management will continue to "rise" along with its products.

Judith Collins/Alamy Stock Photo

[5]Reuters, Profile: Panera Bread (PNRA.O), **www.reuters.com/finance/stocks/companyProfile?symbol=PNRA.O**, April 6, 2017.
[6]Panera Bread Company, 2015 Annual Report to Stockholders, **www.panerabread.com/content/dam/panerabread/documents/financial/2016/pbc-annual-report-2015.pdf.**

1.2 IMPORTANT TRENDS

As we shall see, operations management and supply chain management are as much philosophical approaches to business as they are bodies of tools and techniques, and thus they require a great deal of interaction and trust between companies. For right now, however, let's talk about three enduring trends that will continue to attract the attention of operations and