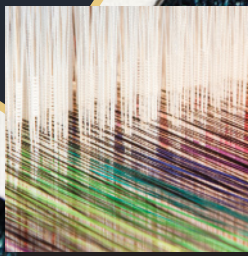


OPERATIONS AND SUPPLY CHAIN MANAGEMENT  
**RUSSELL & TAYLOR**  
EIGHTH EDITION





# OPERATIONS AND SUPPLY CHAIN MANAGEMENT

EIGHTH  
EDITION



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**WILEY**

*To my mother, Margaret Snead, with appreciation  
for her love and support.*

*To my mother, Jean V. Taylor,  
and in memory of my father, Bernard W. Taylor Jr.,  
with love and appreciation.*

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## Changes in the Eighth Edition

This new eighth edition is organized around the important and prevalent topic of operations as the creation of value along the supply chain. We describe how every chapter topic fits within a supply chain framework in a company or organization in an increasingly global operating environment. To reflect this emphasis, the title of the text has been changed to *Operations and Supply Chain Management*. Two chapters deal directly with supply chain management: Chapter 10, Supply Chain Management Strategy and Design, and Chapter 11, Global Supply Chain Procurement and Distribution. However, every chapter includes material relating the chapter topics to supply chain management in a global operating environment. In addition, Chapter 5, Service Design, reflects the expanding presence and importance of the service sector in operations management. We have also added new material throughout the book on the increasingly important OM topics of sustainability, corporate social responsibility, and risk and resilience. To help us show how the OM topics in this new edition fit together within a supply chain framework, we open each chapter with a specific example about one product, *denim jeans*. Denim jeans are an ideal product to use as an example to introduce all the various operations and supply chain management topics in this text because it's a familiar and popular product to our readers, its supply chain is global, and its production process is straightforward and interesting.

In addition to opening each chapter with a denim jeans example, this new edition also includes 86 “Along the Supply Chain” boxes, 55 of which are new, that describe real-world business applications of OM topics at companies around the world. Many of these boxes focus on the increasingly important topics of sustainability and global supply chains. The boxes conclude with critical thinking questions that can be used for assignments and in-class or online discussion.

Chapter 1 focuses on examples of excellence in operations management, current issues in operations and supply chain management, and the strategic design of operations and supply chain management. Chapter 2, Quality Management, emphasizes the necessity and use of quality management systems throughout the supply chain. Chapter 3 introduces statistical process control as essential to ensuring quality along the supply chain.

Chapter 4 has expanded sections on Design for the Environment and Collaborative Product Design Systems. Chapter 5 incorporates new statistics on the service economy, the blending of products and services, and expanded tools for service design. A streamlined waiting line analysis section is also included in the chapter. Chapter 6 emphasizes process analysis skills and includes revised material on making wise outsourcing decisions. Chapter 7 incorporates strategies for capacity management, facility selection and design, green facilities and examples of various service layouts.

Chapter 8, Human Resources, has an increased emphasis on sustainability in the workplace, especially among global suppliers of U.S. companies, as well as increased attention to employee cultural and diversity issues. Chapter 9, Project Management, has an increased focus on cultural and diversity issues in the management of global projects, plus a new section on project risk and how to manage it. Chapter 10, Supply Chain Management Strategy and Design, has a new section on risk and resilience in global supply chains, and increased attention to global sustainability issues. Chapter 11, Global Supply Chain Procurement and Distribution, also addresses sustainability issues, and a new section has been added on spend analysis. Chapter 12, Forecasting, includes a new section on the increasingly important IT topic of data mining, and Chapter 13, Inventory Management, emphasizes its important role in controlling costs along a global supply chain.

Chapter 14 emphasizes the need for effective Sales and Operations Planning, and includes a section on Revenue Management. Chapter 15, Resource Planning, updates resource planning with discussions of cloud computing, in-memory computing, collaborative resource planning and product lifecycle management. Chapter 16 expands Lean Systems to lean services, including lean supply chains, and lean and the environment. Chapter 17 incorporates employee scheduling, artificial intelligence, and theory of constraints, along with traditional scheduling methods.

In addition to this new topical coverage, this edition also includes new updated exhibits in every chapter reflecting the latest versions of *Excel*, *OM Tools*, and *Microsoft Project*. *Excel*, *OM Tools* or *MS Project* files of every exhibit in the text are available to instructors and students on the text website. For instructors, a printable *Solutions Manual* in Word is supplemented with *Excel* or *Microsoft Project* files for virtually every problem and case in the text.

A digital *Instructors Resource Manual* outlines each chapter and provides additional examples to be used in class, along with teaching tips, video suggestions, questions for class discussions, and experiential exercises. Additional online material includes Virtual Tours, Internet Exercises, *YouTube* videos, Practice Quizzes, and Weblinks to companies and topics discussed in each chapter.

## Major Text Themes

### OPERATIONS STRATEGY: CREATING VALUE ALONG THE SUPPLY CHAIN

A company's plan for being competitive is its strategy. The success of a strategic plan is largely determined by how well a company coordinates all of its internal processes, including operations, with its suppliers and customers to produce products and services that provide value. Throughout this book, we try to show how the functions and processes described in each chapter fit into a company's strategic design for the creation of value. In each chapter, we emphasize the need for considering the overall strategic implications of particular operating decisions.

One way in which companies can gain a competitive edge is by deploying the basic functions of operations management in a more effective manner than their rivals, e.g., build a better supply chain. Therefore, we give literally dozens of examples that explain how companies deploy specific operations functions along their supply chain to provide value and make them successful. Throughout the book, "Along the Supply Chain" boxes describe how successful companies have gained a competitive edge through operations.

### GLOBAL OPERATIONS

Companies and organizations today must increasingly compete in a global marketplace. The establishment of new trade agreements between countries, innovations in information technology, and improvements in transport and shipping are just a few of the factors that have enabled companies to develop global supply chains. The opening of the global marketplace has only served to introduce more competitors and make competition tougher, thus making strategic supply chain design even more important for achieving success. In this edition, we introduce this global aspect of operations into every chapter. In each chapter, we include examples that touch on the impact of global operations relative to the topic under discussion, and we discuss how globalization affects supply chain management.

### SUSTAINABILITY

Environmental concerns are changing every aspect of operations and supply chain management from product and service design, to supplier sourcing, to manufacture and delivery. In virtually every chapter of this text we address the impact of "sustainability" (i.e., meeting present needs without sacrificing future resources) and give examples of "green practices". For example, in Chapter 4 on product design, we discuss the design for environment lifecycle, eco-labeling, recycling and reuse, and sustainable operations. In Chapter 6 on processes we discuss green manufacturing; and in Chapter 7 on facilities we discuss LEED certified green buildings. In Chapter 8 we discuss how companies achieve a sustainable work place when they have suppliers around the world. In Chapter 10 on supply chain management we discuss sustainable sourcing in a global environment; and in Chapter 16 on lean systems we discuss lean and the environment.

### SERVICES AND MANUFACTURING

We have attempted to strike a balance between manufacturing and service operations in this book. Traditionally, operations and supply chain management was thought of almost exclusively in a manufacturing context. However, in the United States and other industrialized nations, there has been a dramatic

shift toward service industries. Thus, managing service operations is an important area of study. In many cases, operations and supply chain management processes and techniques are indistinguishable between service and manufacturing. However, in many other instances, service operations present unique situations and problems that require focused attention and unique solutions. We have tried to reflect the uniqueness of service operations by providing focused discussions on service operations throughout the text. For example, in Chapter 2 on quality management we specifically address the importance of quality management in service companies, in Chapter 5 on Service Design we emphasize the differences in design considerations between manufacturing and services, and in Chapter 14 we discuss aggregate planning in services. One type of service examined in virtually every chapter in the book is health care.

## QUALITATIVE AND QUANTITATIVE PROCESSES

We have also attempted to strike a balance between the qualitative (or managerial) aspects of operations management and the quantitative aspects. In the contemporary world of operations management, the quantitative and technological aspects are probably more important than ever. The ability to manage people and resources effectively, to motivate, organize, control, evaluate, and adapt to change, have become critical to competing in today's global markets. Thus, throughout this book we seek to explain and clearly demonstrate how the successful operations manager manages, and how to use quantitative techniques and technology when they are applicable.

However, we attempt to present these quantitative topics in a way that's not overly complex or mathematically intimidating. Above all, we want to show how the quantitative topics fit in with, and complement, the qualitative aspects of operations management. We want you to be able to see both "the forest and the trees."

## Teaching and Learning Support Features

This text is accompanied by many features and supplements both in the text and online for students and instructors.

## PEDAGOGY IN THE TEXTBOOK

### "Along the Supply Chain" Boxes

These boxes are located in every chapter in the text. They describe the application of operations in a real-world company, organization or agency related to specific topics in each chapter. They emphasize how companies effectively compete with operations management in the global marketplace. The descriptions of operations at actual companies in these boxes help the student understand how specific OM techniques and concepts are used by companies, which also make the topics and concepts easier to understand. In addition, we have added discussion questions to these boxes to help students and teachers "connect" the example to the chapter topics.

### OM Dialogue Boxes

These boxes include dialogues with recent college business school graduates who are working in operations management in the real world. They describe how they apply various OM topics in the text in their own jobs and the value of their own OM training in college. This provides students with a perspective on the benefit of studying operations management now and its future benefit.

### Marginal Notes

Notes are included in the margins that serve the same basic function as notes that students themselves might write in the margin. They highlight important topics, making it easier for students to locate them; they summarize important points and key concepts and provide brief definitions of key terms.

### Examples

The primary means of teaching the various quantitative topics in this text is through examples. These examples are liberally distributed throughout the text to demonstrate how problems are solved in a clear, straightforward approach to make them easier to understand.

### Solved Problems

At the end of each chapter, just prior to the homework questions and problems, there is a section with solved examples to serve as a guide for working the homework problems. These examples are solved in a detailed, step-by-step manner.

### Summary of Key Formulas

These summaries at the end of each chapter and supplement include all of the key quantitative formulas introduced in the chapter in one location for easy reference.

### Summary of Key Terms

Located at the end of each chapter, these summaries provide a list of key terms introduced in that chapter and their definitions in one convenient location for quick and easy reference.

### Homework Problems, Questions, and Cases

Our text contains a large number of end-of-chapter exercises for student assignments. There are over 650 homework problems and 56 more advanced case problems. There are also 500 discussion questions including new questions. Answers to selected odd-numbered homework problems are included in the back of the book. As we mention in the following “Online Resources for Instructors” section, Excel spreadsheet solution files are available to the instructor for the majority of the end-of-chapter problems and cases.

## Online Resources For Students, [www.Wiley.Com/College/Russell](http://www.Wiley.Com/College/Russell)

No other innovation has affected operations management in the past few years as much as computer technology and the Internet, and this is no less true in education. Therefore, we make full use of this technology as a learning and teaching medium in the courses we teach and in our text. Students can link to the text website where an exciting set of Internet resources have been compiled.

The text website contains animated demo problems, interactive applications and exercises, and direct links to other sources on the Internet. These various resources and learning tools are organized by chapter and are flagged in the textbook with a web icon. Here are some of the items found on the text website:

- **Web links** for companies and concepts discussed in each chapter can be accessed online. These provide enrichment for those students who want to learn more about a topic, and serve as a valuable resource for student assignments and papers.
- **Virtual Tours** provided for each chapter bring operations management to life. Selected tours are accompanied by a set of questions directly related to concepts discussed in the chapter.
- **Internet Exercises** provide up-to-date access to current issues in operations. These add immediacy to classroom discussions and ensure that operations management topics remain relevant to the student.
- **Practice Quizzes** are provided online where students can get immediate feedback on their progress.

### EXCEL FILES OF EXHIBITS

Excel is used extensively throughout the text to solve various quantitative problems and many Excel illustrations are provided throughout the text.

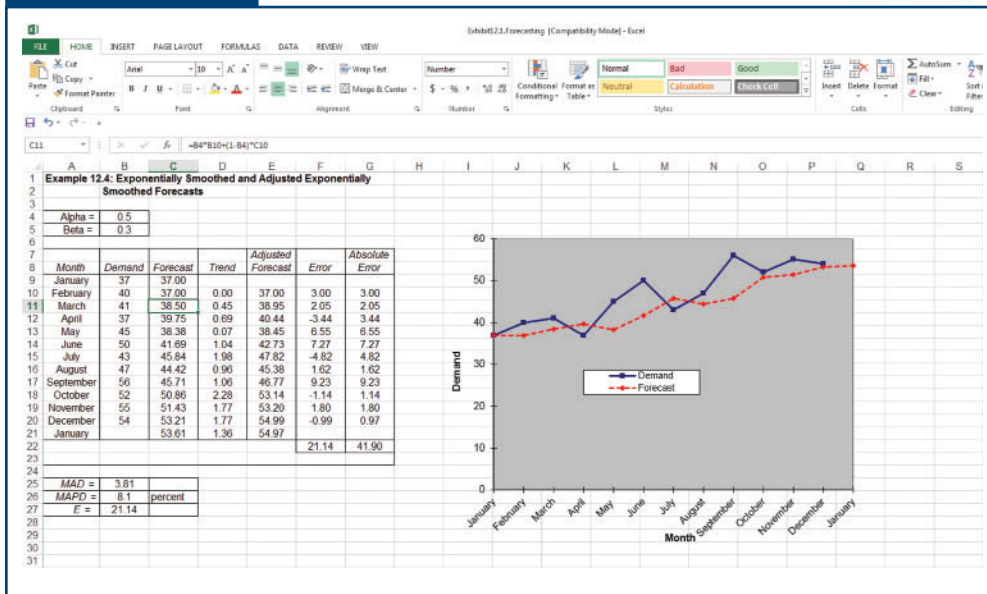
Every Excel spreadsheet used to prepare the examples in the text is available on the text website for students and instructors. They are organized by chapter and are listed by their exhibit number. Above is an example of Exhibit 12.1 from Chapter 12 (Forecasting). Notice the file name is simply the exhibit number plus the topic (i.e., Exhibit 12.1. Forecasting). Please look in each file carefully. In many cases, several sheets in one file have been used to display different parts of a problem, such as a graphical solution as well as a numerical solution. Example files are also available for MS Project files in Chapter 9.

### ONLINE RESOURCES FOR INSTRUCTORS

[www.wiley.com/college/russell](http://www.wiley.com/college/russell)

**Instructor’s Manual** The Instructor’s Manual, updated by the authors, features, chapter outlines, teaching notes, experiential exercises, alternate examples to those provided in the text, pause

**EXHIBIT 12.1**



and reflect questions for classroom discussion, and suggested online videos to use in class or assign for homework.

**Test Bank** Fully revised from the previous edition by Scott Hedin of Gonzaga University this test bank consists of true/false, multiple-choice, short answer, and essay questions. All questions have been carefully accuracy-checked to ensure the highest quality of materials for our customers. The questions are also available electronically on the textbook support site. The Computerized Test Bank, for use on a PC running Windows, is from a test-generating program that allows instructors to modify and add questions in order to customize their exams.

**PowerPoint Presentation Slides** The PowerPoint presentation slides, revised by Lance Matheson of Virginia Tech, include outlines for every chapter, exhibits from the text, and additional examples, providing instructors with a number of learning opportunities for students. The PowerPoint slides can be accessed on the instructor’s portion of the 8<sup>th</sup> edition website. Lecture notes accompany each slide.

**Solutions Manual** The Solutions Manual, updated by the authors, features detailed answers to end-of-chapter questions, homework problems, and case problems.

**Excel Homework Solutions and Excel Exhibit Files** This new edition includes 654 homework problems and 56 case problems. Excel solution files for the instructor are provided on the website for the majority of these problems. In addition, Microsoft Project solution files are provided for most of the homework problems in Chapter 9 (Project Management). Excel worksheets for class handouts or homework assignments are provided for QFD, process flow charts, MRP matrices, and others. Excel exhibit files for every example in the text solved with Excel are provided as templates for solving similar problems for both student and instructor and are available on the text website.

**Web Quizzes** These online quizzes, revised by Scott Hedin of Gonzaga University, vary in level of difficulty and are designed to help your students evaluate their individual progress through a chapter. Web quizzes are available on the student portion of the website. Here students will have the ability to test themselves with 15–20 questions per chapter that include true-false and multiple choice questions.

**OM Tools** OM Tools is an Excel add-in designed to accompany the Russell/Taylor, *Operations and Supply Chain Management*, 8<sup>th</sup> edition text. The software consists of 18 modules with over 60 problem types. OM Tools is easy to use and interpret, and is accompanied by a help file with text references.

**Virtual Tours** are online tours of service and production facilities. Selected tours are made available to students on the student portion of the website, along with questions that help students apply the concepts they’ve learned in the text to real-world companies. A Virtual Tours Master List, organized by industry, contains links to over 200 online tours that instructors may use for assignments or classroom presentation.

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R.S.R and B.W.T

# Introduction to Operations and Supply Chain Management



Redchopsticks/Corbis

## LEARNING OBJECTIVES

### AFTER READING THIS CHAPTER, YOU WILL BE ABLE TO:

- Describe what the operations function is and how it relates to other business functions.
- Discuss the key factors that have contributed to the evolution of operations and supply chain management.
- Discuss how and why businesses operate globally, and the importance of globalization in supply chain management.
- Calculate and interpret productivity measures used for measuring competitiveness.
- Discuss the importance of operations and supply chain management to a firm's strategy, and the process of developing, aligning and deploying strategy.

## YOUR JEANS ARE YOU

There is no more popular garment worldwide than jeans. Jeans symbolize the American west, youth, and hard work and, because they shrink and fade with wear, YOU and the life you've lived in them.

Although jeans are most associated with the German immigrant to the United States, Levi Strauss, the name *jeans* comes from the "Genoese" sailors in Italy who wore trousers made of indigo fabric, called "serge de Nimes," made in Nimes, France. De Nimes fabric, or denim, is cross woven of white and indigo cotton yarn. Since the indigo dye does not penetrate both yarns, the cloth fades with time. The precise manner in which it fades and conforms to the body is related to how the consumer "wears" the jeans; thus, jeans take on a personal patina with time.

## WEB RESOURCES FOR THIS CHAPTER INCLUDE

- OM TOOLS SOFTWARE
- INTERNET EXERCISES
- ONLINE PRACTICE QUIZZES
- LECTURE SLIDES IN POWERPOINT
- VIRTUAL TOURS
- EXCEL EXHIBITS
- COMPANY AND RESOURCE WEBLINKS
- ONLINE VIDEOS



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Jeans production ranges from mass produced to hand crafted. Jeans are produced in over 150 countries worldwide and worn in virtually every country on earth, by people of all ages, backgrounds, and social status. Cotton is grown in the United States, India, China, and Turkey. It is spun into yarn and dyed. For the most part, the spinning, dyeing, and weaving of cloth takes place in the factories of southeast Asia, and the cutting and sewing in Mexico, China, Bangladesh, Vietnam, and Pakistan.

We use jeans throughout this text to illustrate the principles of operations and supply chain management. Our journey will take us from quality and design, to processes, technologies, and logistics; from field to factory to distributor to consumer; from your corner store to around the world. We'll plan, source, make, deliver, and evaluate the most up-to-date material on supply chain management. Throughout this journey, we'll make the study of operations personal to you, as you navigate your own path through knowledge acquisition to your educational and career goals.

#### Operations management:

the design, operation, and improvement of productive systems.

**Operations:** a function or system that transforms inputs into outputs of greater value.

**Value chain:** a series of activities from supplier to customer that add value to a product or service.

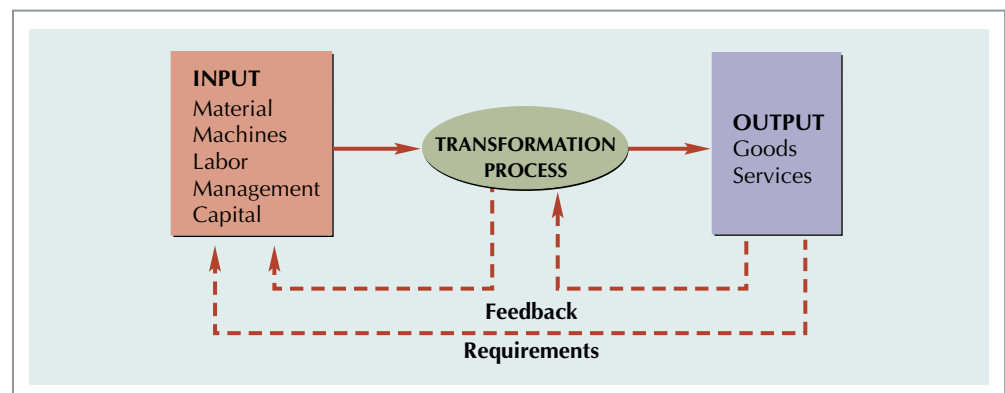
**Operations management** designs, operates, and improves productive systems—systems for getting work done. The food you eat, the movies you watch, the stores in which you shop, and the books you read are provided to you by the people in operations. Operations managers are found in banks, hospitals, factories, and government. They design systems, ensure quality, produce products, and deliver services. They work with customers and suppliers, the latest technology, and global partners. They solve problems, reengineer processes, innovate, and integrate. Operations is more than planning and controlling; it's doing. Whether it's superior quality, speed-to-market, customization, or low cost, excellence in operations is critical to a firm's success.

**Operations** is often defined as a transformation process. As shown in Figure 1.1, inputs (such as material, machines, labor, management, and capital) are transformed into outputs (goods and services). Requirements and feedback from customers are used to adjust factors in the transformation process, which may in turn alter inputs. In operations management, we try to ensure that the transformation process is performed efficiently and that the output is of greater *value* than the sum of the inputs. Thus, the role of operations is to create value. The transformation process itself can be viewed as a series of activities along a **value chain** extending from supplier to customer.

The input–transformation–output process is characteristic of a wide variety of operating systems. In an automobile factory, sheet steel is formed into different shapes, painted and finished, and then assembled with thousands of component parts to produce a working automobile. In an aluminum factory, various grades of bauxite are mixed, heated, and cast into ingots of different sizes. In a hospital, patients are helped to become healthier individuals through special care,

Figure 1.1

Operations as a Transformation Process



# ALONG THE SUPPLY CHAIN

## What Do Operations and Supply Chain Managers Do?

Operations managers are the *improvement people*, the realistic, hard-nosed, make-it-work, get-it-done people; the planners, coordinators, and negotiators. They perform a variety of tasks in many different types of businesses and organizations.



jsmith/iStockphoto



Joerg Boethling/Alamy

Let's meet Claire Thielen, director of informatics for a healthcare system; Ada Liu, division manager for Li & Fung Trading Company; and Erin Hiller, food technologist at a major branded food manufacturer.

Claire Thielen is a healthcare professional who specializes in decision support, process improvement, and organizational performance. She facilitates interdisciplinary teams as they pursue continuous quality improvement projects and analyzes methods and systems for managing information. Her



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Getty Images

projects include determining staffing patterns and workflow for computerized scheduling systems; consolidating policies, procedures, and practices for hospital mergers; developing and implementing balanced scorecards and benchmarking reports; designing clinical studies of new medication effectiveness; and conducting training sessions on process mapping and analysis. Claire Thielen improves quality, productivity, and information in the healthcare industry.

Ada Liu is a division manager for Li & Fung, a global sourcing company. She coordinates global production and distribution for major players in the garment industry. For one particular trouser order, she had the fabric woven in China (for their unique dyeing process), chose fasteners from Hong Kong and Korea (for their durability), and sent the raw materials to Guatemala for sewing (for their basic skills, low cost, and proximity to the United States). If problems should arise, Liu can reroute the order to one of its 7500 suppliers in 37 countries. Ada Liu is a supply chain expert for Li & Fung.

Erin Hiller is a food technologist at a major branded food manufacturer. She works in research and development (R&D) devising, developing, and testing new products. As part of her job, she travels to manufacturing plants across the country to monitor the ramp-up of production for consumer food products with new formulas or ingredients. She verifies that correct procedures are being followed, samples and tests output for quality and consistency, and revises formulaic recipes as required. She also evaluates new and emerging technologies and determines whether they would be beneficial to the product lines and manufacturing operations. Erin Hiller brings fresh designs to the market, keeps operations up to date, and ensures the safety and quality of the foods you eat every day.

*Sources:* Claire Thielen, LinkedIn, accessed January 10, 2010; Joanne Lee-Young, "Furiously Fast Fashions," *The Industry Standard Magazine*, (June 22, 2001); Interview with Erin Hiller (January 3, 2013).

meals, medication, lab work, and surgical procedures. Obviously, “operations” can take many different forms. The transformation process can be

<i>physical,</i>	as in manufacturing operations;
<i>locational,</i>	as in transportation or warehouse operations;
<i>exchange,</i>	as in retail operations;
<i>physiological,</i>	as in healthcare;
<i>psychological,</i>	as in entertainment; or
<i>informational,</i>	as in communication.

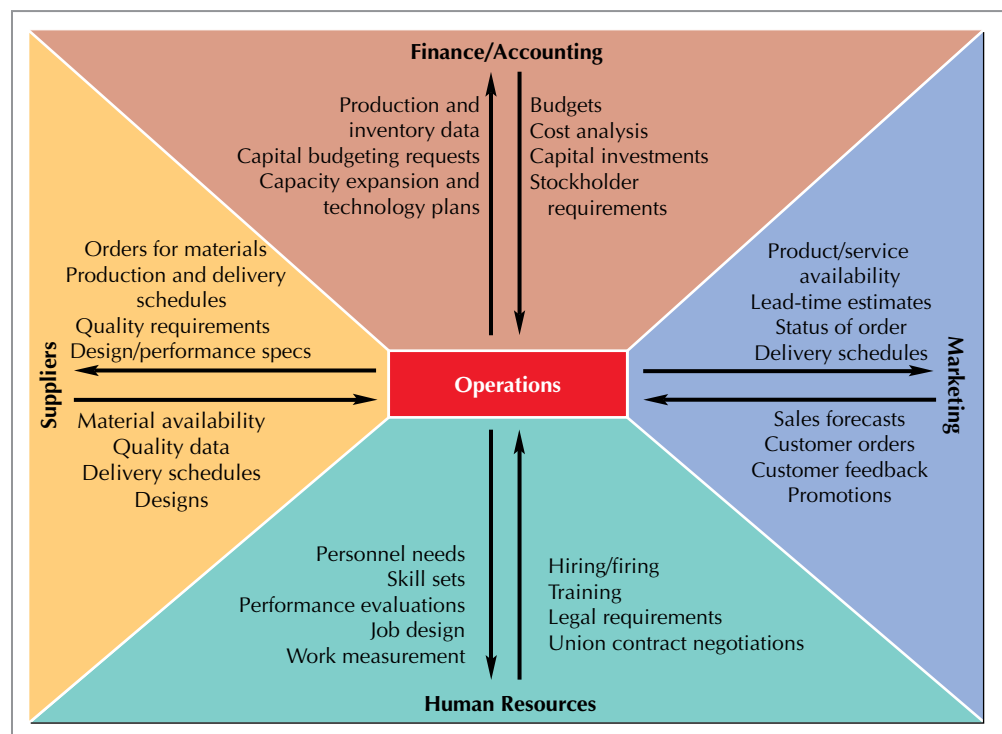
## The Operations Function

Activities in operations management (OM) include organizing work, selecting processes, arranging layouts, locating facilities, designing jobs, measuring performance, controlling quality, scheduling work, managing inventory, and planning production. Operations managers deal with people, technology, and deadlines. These managers need good technical, conceptual, and behavioral skills. Their activities are closely intertwined with other functional areas of a firm.

The four primary functional areas of a firm are marketing, finance, operations, and human resources. As shown in Figure 1.2, for most firms, operations is the technical core or “hub” of the organization, interacting with the other functional areas and suppliers to produce goods and provide services for customers. For example, to obtain monetary resources for production, operations provides finance and accounting with production and inventory data, capital budgeting requests, and capacity expansion and technology plans. Finance pays workers and suppliers, performs cost analyses, approves capital investments, and communicates requirements of shareholders and financial markets. Marketing provides operations with sales forecasts, customer orders, customer feedback, and information on promotions and product development. Operations, in turn, provides marketing with information on product or service availability, lead-time estimates, order status, and delivery schedules. For personnel needs, operations relies on human resources to recruit, train, evaluate, and compensate workers and to assist with legal issues, job design, and union activities. Outside the organization operations interacts with suppliers to order materials or services, communicate production and delivery requirements, certify quality, negotiate contracts, and finalize design specifications.

As a field of study, operations brings together many disciplines and provides an integrated view of business organizations. Operations managers are in demand in business, industry, and government. Chief operating officers (COOs) run major corporations as shown in Figure 1.3,

**Figure 1.2**  
Operations as the  
Technical Core



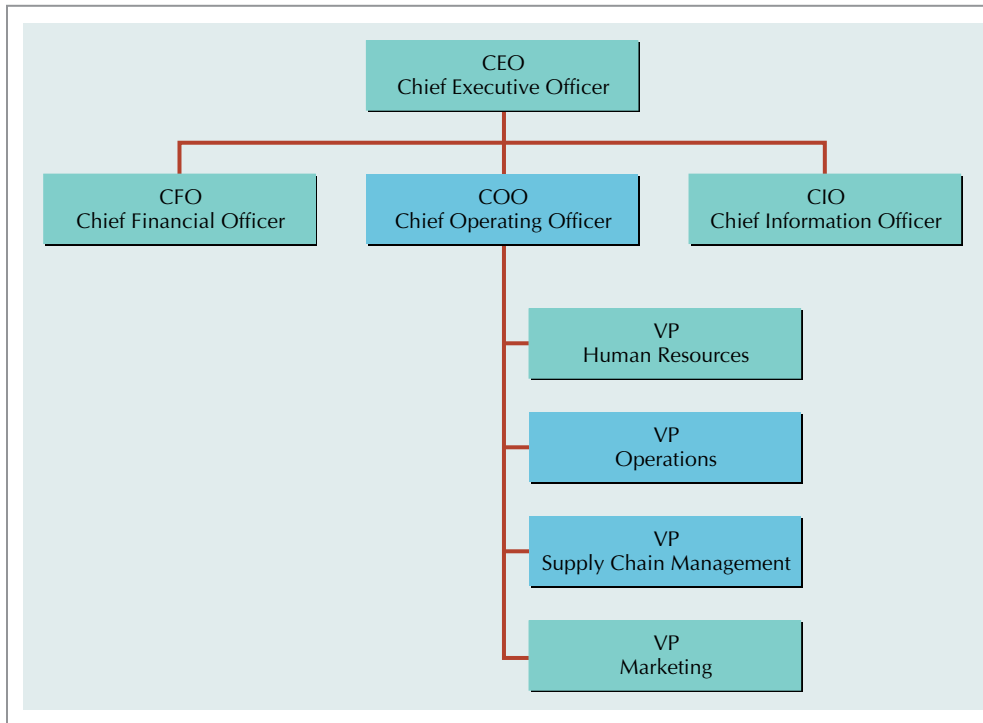


Figure 1.3

Sample Organizational Structure



## MARK JACKSON

### Marketing Manager for Pizza Hut

As regional marketing manager for Pizza Hut, I'm responsible for 21 stores. It's my job to make sure each store is operating properly and, when new products come out, to

see that they are given the attention they deserve. I also coach managers and employees about their job and their relationship with the customer.

You would think that a marketing manager's job would be concerned solely with advertising, special promotions, store signage, customer service, and the like. But we also deal with quality, forecasting, logistics, and other operational issues. Marketing and operations are almost inseparable in services. We can come out with a new product and spend megabucks advertising it, but if the product is not made or delivered properly, all is lost.

The most important aspect of quality is consistency—so that the customer gets the same pizza at any Pizza Hut from whichever cook happens to be on shift. We have exact standards and specifications for our products, and it's important that operating procedures be followed.

Scheduling is somewhat of a headache because of staff turnover and individual limitations on working hours. Some of that is alleviated in our new system where we allow employees to request days off up to six months in advance. They can put requests into the system when they clock in each day, and they can view upcoming schedules.

Our forecasting system keeps historical data on sales by hour and day of the week five years back. Forecasts are weighted averages of past demand—usually 60% of the past two weeks' sales and 40% of the past six weeks' sales. A manager can freeze the forecast and make manual adjustments, such as increasing demand during a home football game weekend or when a local festival is under way. Managers can also enter notes into the system when unusual occurrences affect demand, like a snowstorm. When the forecast is set, it generates a labor plan for the week, along with prep plans for salad, dough, breadsticks, and so forth. The labor plan just specifies the number of workers needed; it is up to the manager to do the detailed scheduling of individuals.

After quality, it's all about speed of delivery—whether to the customer's table or to the customer's home. We have initiatives such as *Ready for Revenue* where we pre-sauce and pre-cheese in anticipation of customer orders, and *Aces in Their Places* where we make sure the best people are scheduled and ready to go for peak demand periods. As for delivery, we keep track of percent of deliveries under 39 minutes and percent of deliveries to promise. We found we could significantly reduce the number of drivers needed (and keep the same customer satisfaction numbers) by promising delivery within 39 minutes rather than 30. We also are more efficient now that dispatching divides our delivery areas into delivery pods and uses computerized estimates of transit time.



**Figure 1.4**

### How Is Operations Relevant to My Major?

Vice-presidents of Operations and Supply Chain Management oversee scores of departments, facilities, and employees. Typical jobs for new college graduates include business process analyst, inventory analyst, project coordinator, unit supervisor, supply chain analyst, materials manager, quality assurance specialist, production scheduler, and logistics planner. Even if you do not pursue a career in operations and supply chain management, you’ll be able to use the ideas you learn in this course to organize work, ensure quality, and manage processes. Regardless of your major, you can apply some aspect of operations and supply chain management to your future career—as did Mark, Nicole, John, Vignesh, Margie, and Anastasia, who tell their stories in Figure 1.4 and the OM Dialogues dispersed throughout the text.

Now that you are aware of how operations might relate to your interests, let’s take a brief look at how the field of operations and supply chain management (OSM) has evolved to its present state.

## The Evolution of Operations and Supply Chain Management

Although history is full of amazing production feats—the pyramids of Egypt, the Great Wall of China, the roads and aqueducts of Rome—the widespread production of consumer goods—and thus, operations management—did not begin until the Industrial Revolution in the 1700s. Prior to that time, skilled craftspersons and their apprentices fashioned goods for individual customers from studios in their own homes. Every piece was unique, hand-fitted, and made entirely by one person, a process known as **craft production**. Although *craft production* still exists today, the availability of coal, iron ore, and steam power set into motion a series of industrial inventions that revolutionized the way work was performed. Great mechanically powered machines replaced the laborer as the primary factor of production and brought workers to a central location to perform tasks under the direction of an “overseer” in a place

**Craft production:** the process of handcrafting products or services for individual customers.



called a “factory.” The revolution first took hold in textile mills, grain mills, metalworking, and machine-making facilities.

Around the same time, Adam Smith’s *Wealth of Nations* (1776) proposed the **division of labor**, in which the production process was broken down into a series of small tasks, each performed by a different worker. The specialization of the workers on limited, repetitive tasks allowed them to become very proficient at those tasks and further encouraged the development of specialized machinery.

The introduction of **interchangeable parts** by Eli Whitney (1790s) allowed the manufacture of firearms, clocks, watches, sewing machines, and other goods to shift from customized one-at-a-time production to volume production of standardized parts. This meant the factory needed a system of measurements and inspection, a standard method of production, and supervisors to check the quality of the worker’s production.

Advances in technology continued through the 1800s. Cost accounting and other control systems were developed, but management theory and practice were virtually nonexistent.

In the early 1900s an enterprising laborer (and later chief engineer) at Midvale Steel Works named Frederick W. Taylor approached the management of work as a science. Based on observation, measurement, and analysis, he identified the best method for performing each job. Once determined, the methods were standardized for all workers, and economic incentives were established to encourage workers to follow the standards. Taylor’s philosophy became known as **scientific management**. His ideas were embraced and extended by efficiency experts Frank and Lillian Gilbreth, Henry Gantt, and others. One of Taylor’s biggest advocates was Henry Ford.

Henry Ford applied scientific management to the production of the Model T in 1913 and reduced the time required to assemble a car from a high of 728 hours to 1½ hours. A Model T chassis moved slowly down a conveyor belt with six workers walking alongside it, picking up parts from carefully spaced piles on the floor and fitting them to the chassis.<sup>1</sup> The short assembly time per car allowed the Model T to be produced in high volumes, or “en masse,” yielding the name **mass production**.

American manufacturers became adept at mass production over the next 50 years and easily dominated manufacturing worldwide. The human relations movement of the 1930s, led by Elton Mayo and the Hawthorne studies, introduced the idea that worker motivation, as well as the technical aspects of work, affected productivity. Theories of motivation were developed by Frederick Herzberg, Abraham Maslow, Douglas McGregor, and others. Quantitative models and techniques spawned by the operations research groups of World War II continued to develop and were applied successfully to manufacturing and services. Computers and automation led still another upsurge in technological advancements applied to operations. These events are summarized in Table 1.1.

From the Industrial Revolution through the 1960s, the United States was the world’s greatest producer of goods and services, as well as the major source of managerial and technical expertise. But in the 1970s and 1980s, industry by industry, U.S. manufacturing superiority was challenged by lower costs and higher quality from foreign manufacturers, led by Japan. Several studies published during those years confirmed what the consumer already knew—U.S.-made products of that era were inferior and could not compete on the world market. Early rationalizations that the Japanese success in manufacturing was a cultural phenomenon were disproved by the successes of Japanese-owned plants in the United States, such as the Matsushita purchase of a failing Quasar television plant in Chicago from Motorola. Part of the purchase contract specified that Matsushita had to retain the entire hourly workforce of 1000 persons. After only two years, with the identical workers, half the management staff, and little or no capital investment, Matsushita doubled production, cut assembly repairs from 130% to 6%, and reduced warranty costs from \$16 million a year to \$2 million a year. You can bet Motorola took notice, as did the rest of U.S. industry.

The **quality revolution** brought with it a realization that production should be tied to consumer demand. Product proliferation, shortened product lifecycles, shortened product development times, changes in technology, more customized products, and segmented markets did not fit mass production assumptions. Using a concept known as just-in-time, Toyota changed the rules of production from mass production to **lean production**, a system that prizes flexibility (rather than efficiency) and quality (rather than quantity).

**Division of labor:** dividing a job into a series of small tasks each performed by a different worker.

**Interchangeable parts:** the standardization of parts initially as replacement parts enabled mass production.

**Scientific management:** the systematic analysis of work methods.

**Mass production:** the high-volume production of a standardized product for a mass market.

**Quality revolution:** an emphasis on quality and the strategic role of operations.

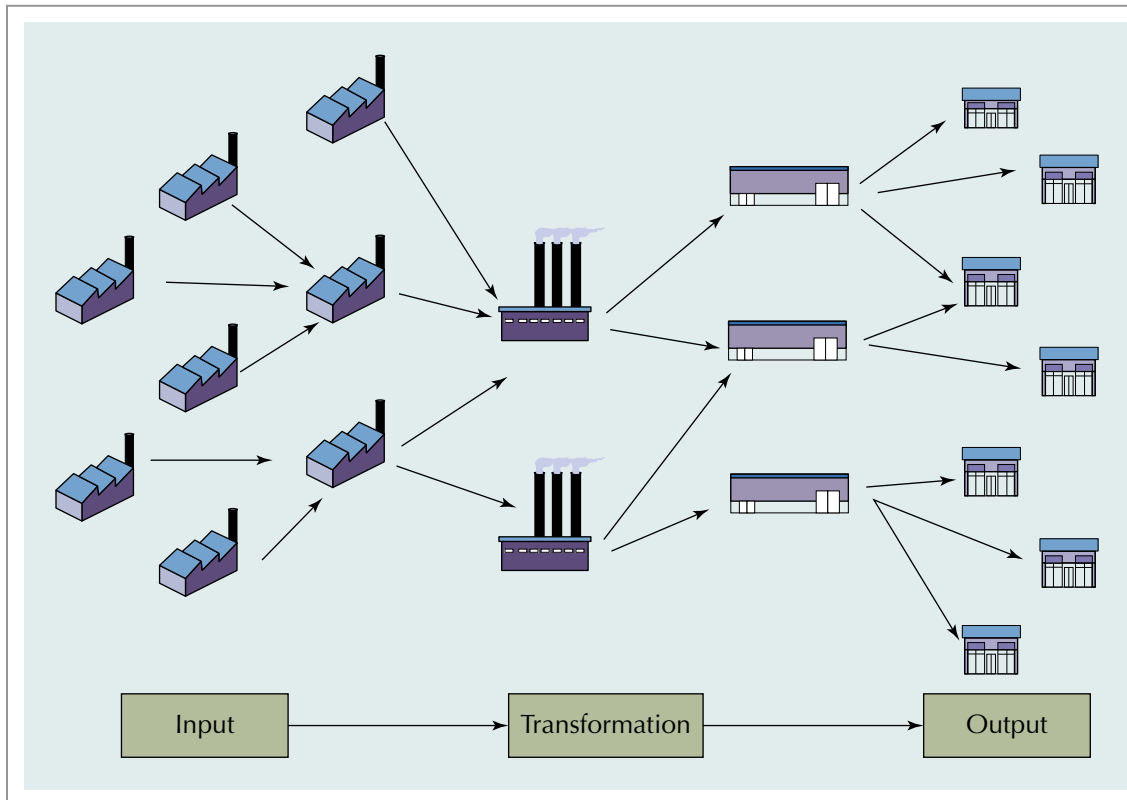
**Lean production:** an adaptation of mass production that prizes quality and flexibility.

<sup>1</sup>David Halberstam, *The Reckoning* (New York: William Morrow, 1986), pp. 79–81.

**TABLE 1.1** Historical Events in Operations Management

Era	Events/Concepts	Dates	Originator
Industrial Revolution	Steam engine Division of labor Interchangeable parts	1769 1776 1790	James Watt Adam Smith Eli Whitney
Scientific Management	Principles of scientific management Time and motion studies Activity scheduling chart Moving assembly line	1911 1911 1912 1913	Frederick W. Taylor Frank and Lillian Gilbreth Henry Gantt Henry Ford
Human Relations	Hawthorne studies Motivation theories	1930 1940s 1950s 1960s	Elton Mayo Abraham Maslow Frederick Herzberg Douglas McGregor
Operations Research	Linear programming Digital computer Simulation, waiting line theory, decision theory, PERT/CPM MRP EDI, CIM	1947 1951 1950s  1960s 1970s	George Dantzig Remington Rand Operations research groups  Joseph Orlicky, IBM, and others Auto industry, DARPA
Quality Revolution	JIT (just-in-time) TQM (total quality management) Strategy and operations  Reengineering  Six Sigma	1970s 1980s  1990s 1990s	Taiichi Ohno (Toyota) W. Edwards Deming, Joseph Juran Wickham Skinner, Robert Hayes Michael Hammer, James Champy GE, Motorola
Internet Revolution	Internet, WWW ERP, supply chain management E-commerce	1990s  2000s	ARPANET, Tim Berners-Lee SAP, Oracle, Dell  Amazon, Yahoo, eBay, Google and others
Globalization	World Trade Organization European Union Global supply chains Outsourcing Services Science	1990s  2000s	GATT Europe China, India Emerging economies IBM
Sustainability	Global warming Carbon footprint Green products Corporate social responsibility (CSR) UN Global Compact	Today	Numerous companies, scientists, statesmen and governments World Economic Forum  United Nations

The renewed emphasis on quality and the *strategic importance* of operations made some U.S. companies competitive again. Others continued to stagnate, buoyed temporarily by the expanding economies of the Internet era and globalization. Productivity soared as return on investment in information technology finally came to fruition. New types of businesses and business models



**Figure 1.5**  
Supply Chain Management

emerged, such as Amazon, Google, and eBay, and companies used the Internet to connect with customers and suppliers around the world. The inflated expectations of the dot-com era came to an end and, coupled with the terrorist attacks of 9/11 and their aftermath, brought many companies back to reality, searching for ways to cut costs and survive in a global economy. They found relief in the emerging economies of China and India, and began accelerating the outsourcing of not only goods production, but services, such as information technology, call centers, and other business processes. The outsourcing of business processes brought with it a new awareness of business-to-business (B2B) services and the need for viewing services as a science.

With more and more activities taking place outside the enterprise in factories, distribution centers, offices and stores overseas, managers needed to develop skills in coordinating operations across a global supply chain. The field of **supply chain management** was born to manage the flow of information, products, and services across a network of customers, enterprises, and supply chain partners. In Figure 1.1, we depicted operations as a transformation process. Extending that analogy in Figure 1.5, supply chain management concentrates on the input and output sides of transformation processes. Increasingly, however, as the transformation process is performed by suppliers who may be located around the world, the supply chain manager is also concerned with the timeliness, quality, and legalities of the supplier's operations.

The era of globalization was in full swing in 2008 when a financial crisis brought on by risky loans, inflated expectations, and unsavory financial practices brought the global economy to a standstill. Operations and supply chain management practices based on assumptions of growth had to be reevaluated for declining markets and resources. Companies began to reassess the value of their business, their customers, and their suppliers with an eye toward focusing on the most critical factors to sustain their business through the downturn.

The next phase in the evolution of OSM is the *Era of Sustainability*, in which countries, companies, and industries evaluate what it takes to sustain the health of their enterprise or people in the long term. This is especially important in light of changes in the environment, natural and man-made disasters, and the competitive landscape.

A recent UN Global Compact Survey reports that 93% of CEOs believe sustainability issues will be critical to the future success of their business. Companies that evaluate firm performance agree. Bloomberg Financials includes an ESG (environment, social, and governance) tool that, among other things, evaluates a company's environmental performance with an Environmental

**Supply chain management:** managing the flow of information, products, and services across a network of customers, enterprises, and suppliers.

**Sustainability is the next era in OSM.**