

Operations Management

Twelfth Edition

William J. Stevenson

*Saunders College of Business
Rochester Institute of Technology*





This book is dedicated to you.

OPERATIONS MANAGEMENT, TWELFTH EDITION

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This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 0 DOW/DOW 1 0 9 8 7 6 5 4

ISBN 978-0-07-802410-8

MHID 0-07-802410-2

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Preface

The material in this book is intended as an introduction to the field of operations management. The topics covered include both strategic issues and practical applications. Among the topics are forecasting, product and service design, capacity planning, management of quality and quality control, inventory management, scheduling, supply chain management, and project management.

My purpose in revising this book continues to be to provide a clear presentation of the concepts, tools, and applications of the field of operations management. Operations management is evolving and growing, and I have found updating and integrating new material to be both rewarding and challenging, particularly due to the plethora of new developments in the field, while facing the practical limits on the length of the book.

This text offers a comprehensive and flexible amount of content that can be selected as appropriate for different courses and formats, including undergraduate, graduate, and executive education.

This allows instructors to select the chapters, or portions of chapters, that are most relevant for their purposes. That flexibility also extends to the choice of relative weighting of the qualitative or quantitative aspects of the material and the order in which chapters are covered because chapters do not depend on sequence. For example, some instructors cover project management early, others cover quality or lean early, etc.

As in previous editions, there are major pedagogical features designed to help students learn and understand the material. This section describes the key features of the book, the chapter elements, the supplements that are available for teaching the course, highlights of the eleventh edition, and suggested applications for classroom instruction. By providing this support, it is our hope that instructors and students will have the tools to make this learning experience a rewarding one.

What's New in This Edition

This edition has been revised to incorporate and integrate changes in the field of Operations Management, and the many suggestions for improvement received from instructors around the world who are using the text. The following are key among the revisions:

- New examples, discussion questions, and problems have been incorporated throughout.
- Some content has been rewritten or added to include current information, improve clarity and help understanding.

- New material and more emphasis have been devoted to these topics:
 - Service
 - Supply chain management
 - Sustainability
 - Step-by-step problem solving
- Throughout the text, there are new, updated readings, and photos to provide students with a motivating view of the critical importance of operations management today.
- Connect Plus for Operations Management is now available with LearnSmart, McGraw-Hill's adaptive learning component. LearnSmart provides assignable modules that help students master core concepts and come to class better prepared.

Acknowledgments

I want to thank the many contributors to this edition. Reviewers and adopters of the text have provided a “continuously improving” wealth of ideas and suggestions. It is encouraging to me as an author. I hope all reviewers and readers will know their suggestions were valuable, were carefully considered, and are sincerely appreciated. The list includes post-publication reviewers.

Robert Aboolian, California State University—San Marcos

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Other contributors include accuracy checkers: Gary Black, University of Southern Indiana, Michael Godfrey, University of Wisconsin at Oshkosh, and Richard White, University of North Texas; Test Bank: Alan Cannon, University of Texas at Arlington; PowerPoints: David Cook, Old Dominion University; Data Sets: Mehdi Kaighobadi, Florida Atlantic University; Excel Templates and ScreenCam tutorials: Lee Tangedahl, University of Montana; Instructors Manual: Michael Godfrey.

Special thanks goes out to Larry White, Eastern Illinois University, who helped revise, design, and develop interactive content in *Connect[®] Operations Management* for this edition:

Finally I would like to thank all the people at McGraw-Hill/Irwin for their efforts and support. It is always a pleasure to work with such a professional and competent group of people. Special thanks go to Thomas Hayward, Senior Brand Manager; Wanda Zeman, Senior Development Editor; Kristin Bradley, Project Manager; Debra Sylvester, Buyer; Heather Kazakoff, Senior Marketing Manager; Srdjan Savanovic, Designer; Rachel Townsend, Content Project Manager; Keri Johnson, Senior Photo Research Coordinator, and many others who worked “behind the scenes.”

I would also like to thank the many reviewers of previous editions for their contributions. Vikas Agrawal, Fayetteville State University; Bahram Alidaee, University of Mississippi; Ardavan Asef-Faziri, California State University at Northridge; Prabir Bagchi, George Washington State University; Gordon F. Bagot, California State University at Los Angeles; Ravi Behara, Florida Atlantic University; Michael Bendixen, Nova Southeastern; Ednilson Bernardes, Georgia Southern University; Prashanth N. Bharadwaj, Indiana University of Pennsylvania; Greg Bier, University of Missouri at Columbia; Joseph Biggs, Cal Poly State University; Kimball Bullington, Middle Tennessee State University; Alan Cannon, University of Texas at Arlington; Injazz Chen, Cleveland State University; Alan Chow, University of Southern Alabama at Mobile; Chwan-Jyh, Oklahoma State University; Chen Chung, University of Kentucky; Robert Clark, Stony Brook University; Loretta Cochran, Arkansas Tech University; Lewis Coopersmith, Rider University; Richard Crandall, Appalachian State University; Dinesh Dave, Appalachian

State University; Scott Dellana, East Carolina University; Kathy Dhandu, DePaul University; Xin Ding, University of Utah; Ellen Dumond, California State University at Fullerton; Richard Ehrhardt, University of North Carolina at Greensboro; Kurt Engemann, Iona College; Diane Ervin, DeVry University; Farzaneh Fazel, Illinois State University; Wanda Fennell, University of Mississippi at Hattiesburg; Joy Field, Boston College; Warren Fisher, Stephen F. Austin State University; Lillian Fok, University of New Orleans; Charles Foley, Columbus State Community College; Matthew W. Ford, Northern Kentucky University; Phillip C. Fry, Boise State University; Charles A. Gates Jr., Aurora University; Tom Gattiker, Boise State University; Damodar Golhar, Western Michigan University; Robert Graham, Jacksonville State University; Angappa Gunasekaran, University of Massachusetts at Dartmouth; Haresh Gurnani, University of Miami; Terry Harrison, Penn State University; Vishwanath Hegde, California State University at East Bay; Craig Hill, Georgia State University; Jim Ho, University of Illinois at Chicago; Seong Hyun Nam, University of North Dakota; Jonatan Jelen, Mercy College; Prafulla Joglekar, LaSalle University; Vijay Kannan, Utah State University; Sunder Kekre, Carnegie-Mellon University; Jim Keyes, University of Wisconsin at Stout; Seung-Lae Kim, Drexel University; Beate Klingenberg, Marist College; John Kros, East Carolina University; Vinod Lall, Minnesota State University at Moorhead; Kenneth Lawrence, New Jersey Institute of Technology; Jooh Lee, Rowan University; Anita Lee-Post, University of Kentucky; Karen Lewis, University of Mississippi; Bing-guang Li, Albany State University; Cheng Li, California State University at Los Angeles; Maureen P. Lojo, California State University at Sacramento; F. Victor Lu, St. John’s University; Janet Lyons, Utah State University; James Maddox, Friends University; Gita Mathur, San Jose State University; Mark McComb, Mississippi College; George Mechling, Western Carolina University; Scott Metlen, University of Idaho; Douglas Micklich, Illinois State University; Ajay Mishra, SUNY at Binghamton; Scott S. Morris, Southern Nazarene University; Philip F. Musa, University of Alabama at Birmingham; Roy Nersesian, Monmouth University; Jeffrey Ohlmann, University of Iowa at Iowa City; John Olson, University of St. Thomas; Ozgur Ozluk, San Francisco State University; Kenneth Paetsch, Cleveland State University; Taeho Park, San Jose State University; Allison Pearson, Mississippi State University; Patrick Penfield, Syracuse University; Steve Peng, California State University at Hayward; Richard Peschke, Minnesota State University at Moorhead; Andru Peters, San Jose State University; Charles Phillips, Mississippi State University; Frank Pianki, Anderson University; Sharma Pilitla, Towson University; Zinovy Radovitsky, California State University at Hayward; Stephen A. Raper, University of Missouri at Rolla; Pedro Reyes, Baylor University; Buddhadev Roychoudhury, Minnesota State University

at Mankato; Narendra Rustagi, Howard University; Herb Schiller, Stony Brook University; Dean T. Scott, DeVry University; Scott J. Seipel, Middle Tennessee State University; Raj Selladurai, Indiana University; Kaushic Sengupta, Hofstra University; Kenneth Shaw, Oregon State University; Dooyoung Shin, Minnesota State University at Mankato; Michael Shurden, Lander University; Raymond E. Simko, Myers University; John Simon, Governors State University; Jake Simons, Georgia Southern University; Charles Smith, Virginia Commonwealth University; Kenneth Solheim, DeVry University; Young Son, Bernard M. Baruch College; Victor Sower, Sam Houston State University; Jeremy Stafford, University of North Alabama; Donna Stewart, University of Wisconsin at Stout; Dothang Truong, Fayetteville State University; Mike Umble, Baylor University; Javad Varzandeh, California State University

at San Bernardino; Timothy Vaughan, University of Wisconsin at Eau Claire; Emre Veral, Baruch College; Mark Vroblefski, University of Arizona; Gustavo Vulcano, New York University; Walter Wallace, Georgia State University; James Walters, Ball State University; John Wang, Montclair State University; Tekle Wanorie, Northwest Missouri State University; Jerry Wei, University of Notre Dame; Michael Whittenberg, University of Texas; Geoff Willis, University of Central Oklahoma; Pamela Zelbst, Sam Houston State University; Jiawei Zhang, NYU; Zhenying Zhao, University of Maryland; Yong-Pin Zhou, University of Washington.

William J. Stevenson

Walkthrough

MAJOR STUDY AND LEARNING FEATURES

A number of key features in this text have been specifically designed to help introductory students learn, understand, and apply Operations concepts and problem-solving techniques.

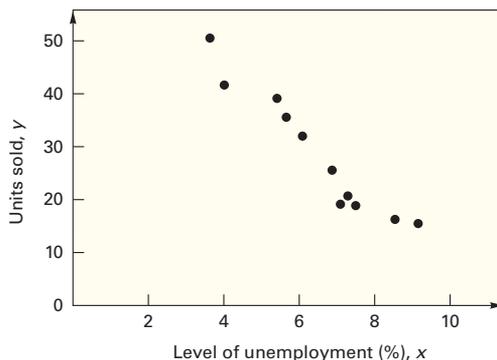
Examples with Solutions

Throughout the text, wherever a quantitative or analytic technique is introduced, an example is included to illustrate the application of that technique. These are designed to be easy to follow.

Sales of new houses and three-month lagged unemployment are shown in the following table. Determine if unemployment levels can be used to predict demand for new houses and, if so, derive a predictive equation.

| | | | | | | | | | | | |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Period | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Units sold | 20 | 41 | 17 | 35 | 25 | 31 | 38 | 50 | 15 | 19 | 14 |
| Unemployment % (three-month lag) | 7.2 | 4.0 | 7.3 | 5.5 | 6.8 | 6.0 | 5.4 | 3.6 | 8.4 | 7.0 | 9.0 |

1. Plot the data to see if a *linear* model seems reasonable. In this case, a linear model seems appropriate *for the range of the data*.



2. Check the correlation coefficient to confirm that it is not close to zero using the Web site template, and then obtain the regression equation:

$$r = -.966$$

This is a fairly high negative correlation. The regression equation is

$$y = 71.85 - 6.91x$$

Note that the equation pertains only to unemployment levels in the range 3.6 to 9.0, because sample observations covered only that range.

EXAMPLE 10

eXcel

mhhe.com/stevenson12e

SOLUTION

Solved Problems

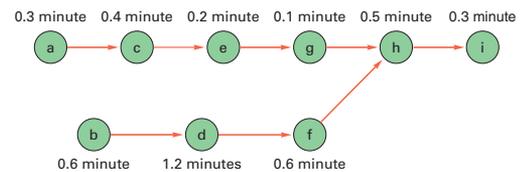
At the end of chapters and chapter supplements, “solved problems” are provided to illustrate problem solving and the core concepts in the chapter. These have been carefully prepared to help students understand the steps involved in solving different types of problems. The Excel logo indicates that a spreadsheet is available on the text’s Web site, to help solve the problem.

SOLVED PROBLEMS

Problem 1

The tasks shown in the following precedence diagram are to be assigned to workstations with the intent of minimizing idle time. Management has designed an output rate of 275 units per day. Assume 440 minutes are available per day.

- Determine the appropriate cycle time.
- What is the minimum number of stations possible?
- Assign tasks using the “positional weight” rule: Assign tasks with highest following times (including a task’s own time) first. Break ties using greatest number of following tasks.
- Compute efficiency.



Solution

$$a. \text{ Cycle time} = \frac{\text{Operating time}}{\text{Desired output}} = \frac{440 \text{ minutes per day}}{275 \text{ units per day}} = 1.6 \text{ minutes per unit}$$

TABLE 16.5 Excel solution for Example 2a

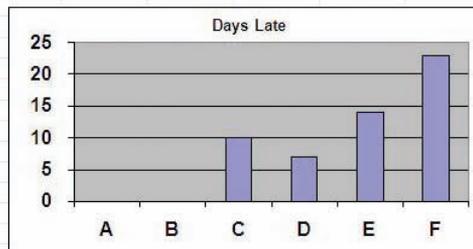
| Job Sequencing | | | | | | | | | | | |
|--------------------------|---------------|-----------------------|--------------|---------------|----------------|-------|-----|-----------|-----------|-----|--|
| <Back | | Notes | | Clear | | FCFS | | SPT | | DD | |
| | | | | | | | | | | CR | |
| | | | | | | | | | | S/O | |
| | | | | Current Date: | | 23 | | | | | |
| Job | Process. Time | Due Date | Remain Oper. | CR Sequence | Critical Ratio | Slack | S/O | Flow Time | Days Late | | |
| A | 2 | 7 | | 3 | | 5 | | 2 | 0 | | |
| B | 8 | 16 | | 5 | | 8 | | 10 | 0 | | |
| C | 4 | 4 | | 1 | | 0 | | 14 | 10 | | |
| D | 10 | 17 | | 6 | | 7 | | 24 | 7 | | |
| E | 5 | 15 | | 4 | | 10 | | 29 | 14 | | |
| F | 12 | 18 | | 2 | | 6 | | 41 | 23 | | |
| Totals | 41 | | 0 | | | 36 | | 120 | 54 | | |

| Method | FCFS |
|------------------------|-------|
| Average Flow Time | 20.00 |
| Average Tardiness | 9.00 |
| Average Number of Jobs | 2.93 |

See notes below.

Notes:

- Enter Job Name, Processing Time, and Due Date for each job.
- For the FCFS, SPT, and DD rules, simply press the appropriate button.
- For the CR rule, perform the following BEFORE pressing the CR button:
 - Select job with lowest Critical Ratio
 - Schedule that job next by entering next sequence number (start with 1) in the CR Sequence column.
 - Add the processing time for that job to the current date.
 - Repeat steps a, b, and c until all jobs have been scheduled (i.e. the CR Sequence column is filled in).
 - Then press the CR button.
- Fill in the Remaining Operations column and then press the S/O button.



Excel Spreadsheet Solutions

Where applicable, the examples and solved problems include screen shots of a spreadsheet solution. Many of these were taken from the Excel templates, which are on the text’s website. Templates are programmed to be fully functional in Excel 2013 and earlier.

CHAPTER ELEMENTS

Within each chapter, you will find the following elements that are designed to facilitate study and learning. All of these have been carefully developed over many editions and have proven to be successful.

Chapter Outlines

Every chapter and supplement includes an outline of the topics covered.

4

CHAPTER

Product and Service Design

CHAPTER OUTLINE

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LEARNING OBJECTIVES

After completing this chapter, you should be able to:

L04.1 Explain the strategic importance of product and service design.

L04.2 Describe what product and service design does.

L04.3 Name the key questions of product and service design.

L04.4 Identify some reasons for design or redesign.

L04.5 List some of the main sources of design ideas.

L04.6 Discuss the importance of legal, ethical, and sustainability considerations in product and service design.

L04.7 Explain the purpose and goal of life cycle assessment.

L04.8 Explain the phrase "the 3 Rs."

L04.9 Briefly describe the phases in product design and development.

L04.10 Discuss several key issues in product or service design.

L04.11 Discuss the two key issues in service design.

L04.12 List the characteristics of well-designed service systems.

L04.13 List some guidelines for successful service design.



The essence of a business organization is the products and services it offers, and every aspect of the organization and its supply chain are structured around those products and services. Organizations that have well-designed products or services are more likely to realize their goals than those with poorly designed products or services. Hence, organizations have a strategic interest in product and service design. Product or service design should be closely tied to an organization's strategy. It is a major factor in cost, quality, time-to-market, customer satisfaction, and competitive advantage. Consequently, marketing, finance, operations, accounting, IT, and HR need to be involved. Demand forecasts and projected costs are important, as is the expected impact on the supply chain. It is significant to note that an important cause of operations failures can be traced to faulty design. Designs that have not been well thought out, or incorrectly implemented, or instructions for assembly or usage that are wrong or unclear, can be the cause of product and service failures, leading to lawsuits, injuries and deaths, product recalls, and damaged reputations.

L04.1 Explain the strategic importance of product and service design.

The introduction of new products or services, or changes to product or service designs, can have impacts throughout the organization and the entire supply chain. Some processes may change very little, while others may have to change considerably in terms of what they do or how and when they do it. New processes may have to be added, and some current ones may be eliminated. New suppliers and distributors may need to be found and integrated into the system, and some current suppliers and distributors may no longer be an appropriate fit. Moreover, it is necessary to take into account projected impact on demand as well as financial, marketing, and distribution implications. Because of the potential for widespread effects, taking a "big picture" systems approach early and throughout the design or redesign process is imperative to reduce the chance of missing some implications and costs, and to understand the time it will take. Likewise, input from engineering, operations, marketing, finance, accounting, and supply chains is crucial.

In this chapter you will discover insights into the design process that apply to both product and service design.

Learning Objectives

Every chapter and supplement lists the learning objectives to achieve when studying the chapter material. The learning objectives are also included next to the specific material in the margins of the text.

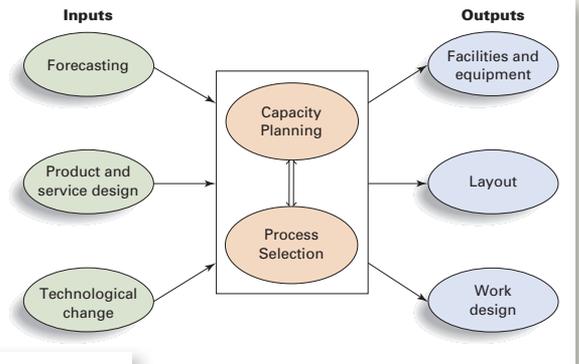
Opening Vignettes

Each chapter opens with an introduction to the important operations topics covered in the chapter. This enables students to see the relevance of operations management in order to actively engage in learning the material.

Figures and Photos

The text includes photographs and graphic illustrations to support student learning and provide interest and motivation. Approximately 100 carefully selected photos highlight the twelfth edition. The photos illustrate applications of operations and supply chain concepts in many successful companies. More than 400 graphic illustrations, more than any other text in the field, are included and all are color coded with pedagogical consistency to assist students in understanding concepts.

FIGURE 6.1
Process selection and capacity planning influence system design



Icons

Icons are included in the text, to point out relevant applications in a discussion or concept. These include: Excel icons  to point out Excel applications; and ScreenCam Tutorial icons  to link to the tutorials on the text's website.

5.12 OPERATIONS STRATEGY

The strategic implications of capacity decisions can be enormous, impacting all areas of the organization. From an operations management standpoint, capacity decisions establish a set of conditions within which operations will be required to function. Hence, it is extremely important to include input from operations management people in making capacity decisions.

Flexibility can be a key issue in capacity decisions, although flexibility is not always an option, particularly in capital-intensive industries. However, where possible, flexibility allows an organization to be agile—that is, responsive to changes in the marketplace. Also, it reduces to a certain extent the dependence on long-range forecasts to accurately predict demand. And flexibility makes it easier for organizations to take advantage of technological and other innovations. Maintaining excess capacity (a capacity cushion) may provide a degree of flexibility, albeit at added cost.

Some organizations use a strategy of maintaining a capacity cushion for the purpose of blocking entry into the market by new competitors. The excess capacity enables them to produce at costs lower than what new competitors can. However, such a strategy means higher-than-necessary unit costs, and it makes it more difficult to cut back if demand slows, or to shift to new product or service offerings.

Efficiency improvements and utilization improvements can provide capacity increases. Such improvements can be achieved by streamlining operations and reducing waste. The chapter on lean operations describes ways for achieving those improvements.

Bottleneck management can be a way to increase effective capacity, by scheduling non-bottleneck operations to achieve maximum utilization of bottleneck operations.

In cases where capacity expansion will be undertaken, there are two strategies for determining the timing and degree of capacity expansion. One is the *expand-early* strategy (i.e., before demand materializes). The intent might be to achieve economies of scale, to expand market share, or to preempt competitors from expanding. The risks of this strategy include an oversupply that would drive prices down, and underutilized equipment that would result in higher unit costs.

The other approach is the *wait-and-see* strategy (materializes, perhaps incrementally). Its advantages are more accurate matching of supply and demand, and loss of market share and the inability to meet demand.

Readings

Readings highlight important real-world applications, provide examples of production/operations issues, and offer further elaboration of the text material. They also provide a basis for classroom discussion and generate interest in the subject matter. Many of the end-of-chapter readings include assignment questions.

Operations Strategies

An Operations Strategy section is included at the ends of most chapters. These sections discuss how the chapters' concepts can be applied and how they impact the operations of a company.

Dutch Boy Brushes Up Its Paints

READING

Sherwin-Williams' Dutch Boy Group has put a revolutionary spin on wall/house painting with its new square-shaped Twist & Pour™ paint-delivery container for the Dirt Fighter interior latex paint line. The four-piece square container could be the first major change in how house paint is packaged in decades. Lightweight but sturdy, the Twist & Pour "bucket" is packed with so many conveniences, it's next to impossible to mess up a painting project.

Winning Best of Show in an AmeriStar packaging competition sponsored by the Institute of Packaging Professionals, the exclusive, all-plastic paint container stands almost 7½ in. tall and holds 126 oz., a bit less than 1 gal. Rust-resistant and moisture-resistant, the plastic bucket gives users a new way to mix, brush, and store paint.

A hollow handle on one side makes it comfortable to pour and [carry]. A convenient, snap-in pour spout neatly pours paint into a tray with no dripping but can be removed if desired, to allow a wide brush to be dipped into the 5¼-in.-dia. mouth. Capping the container is a large, twist-off lid that requires no tools to open or close. Molded with two lugs for a snug-finger-tight closing, the threaded cap provides a tight seal to extend the shelf life of unused paint.

While the lid requires no tools to access, the snap-off carry bail is assembled on the container in a "locked-down position" and can be pulled up after purchase for toting or hanging on a ladder. Large, nearly 4½-in.-tall label panels allow glossy front and back labels printed and UV-coated to wrap around the can's rounded corners, for an impressive display.

Jim MacDonald, co-designer of the Twist & Pour and a packaging engineer at Cleveland-based Sherwin-Williams, tells *Packaging Digest* that the space-efficient, square shape is easier to ship and for retailers to stack in stores. It can also be nested, courtesy of a recess in the bottom that mates with the lid's top ring. "The new design allows for one additional shelf facing on an eight-foot rack or shelf area."



The labels are applied automatically, quite a feat, considering their complexity, size, and the hollow handle they likely encounter during application. MacDonald admits, "Label application was a challenge. We had to modify the bottle several times to accommodate the labeling machinery available."

Source: "Dutch Boy Brushes Up Its Paints," *Packaging Digest*, October 2002. Copyright © 2002 Reed Business Information. Used with permission.

END-OF-CHAPTER RESOURCES

For student study and review, the following items are provided at the end of each chapter or chapter supplement.

Summaries

Chapters contain summaries that provide an overview of the material covered.

Key Points

The key points of the chapter are emphasized.

Key Terms

Key terms are highlighted in the text and then repeated in the margin with brief definitions for emphasis. They are listed at the end of each chapter (along with page references) to aid in reviewing.

Discussion and Review Questions

Each chapter and each supplement have a list of discussion and review questions. These precede the problem sets and are intended to serve as a student self-review or as class discussion starters.

1. Demand forecasts are essential inputs for many business decisions; they help managers decide how much supply or capacity will be needed to match expected demand, both within the organization and in the supply chain.
2. Because of random variations in demand, it is likely that the forecast will not be perfect, so managers need to be prepared to deal with forecast errors.
3. Other, nonrandom factors might also be present, so it is necessary to monitor forecast errors to check for nonrandom patterns in forecast errors.
4. It is important to choose a forecasting technique that is cost-effective and one that minimizes forecast error.

KEY POINTS

Taking Stock and Critical Thinking Exercises

These activities encourage analytical thinking and help broaden conceptual understanding. A question related to ethics is included in the Critical Thinking Exercises.

This item appears at the end of each chapter. It is intended to focus your attention on three key issues for business organizations in general, and operations management in particular. Those issues are trade-off decisions, collaboration among various functional areas of the organization, and the impact of technology. You will see three or more questions relating to these issues. Here is the first set of questions:

1. What are trade-offs? Why is careful consideration of trade-offs important in decision making?
2. Why is it important for the various functional areas of a business organization to collaborate?
3. In what general ways does technology have an impact on operations management decision making?

TAKING STOCK

This item also will appear in every chapter. It allows you to critically apply information you learned in the chapter to a practical situation. Here is the first set of exercises:

1. Many organizations offer a combination of goods and services to their customers. As you learned in this chapter, there are some key differences between production of goods and delivery of services. What are the implications of these differences relative to managing operations?
2. Why is it important to match supply and demand? If a manager believes that supply and demand will not be equal, what actions could the manager take to increase the probability of achieving a match?
3. One way that organizations compete is through technological innovation. However, there can be downsides for both the organization and the consumer. Explain.

CRITICAL THINKING EXERCISES

Problem Sets

Each chapter includes a set of problems for assignment. The problems have been refined over many editions and are intended to be challenging but doable for students. Short answers to most of the problems are included in Appendix A so that students can check their understanding and see immediately how they are progressing.

PROBLEMS

1. Determine the utilization and the efficiency for each of these situations:
 - a. A loan processing operation that processes an average of 7 loans per day. The operation has a design capacity of 10 loans per day and an effective capacity of 8 loans per day.
 - b. A furnace repair team that services an average of four furnaces a day if the design capacity is six furnaces a day and the effective capacity is five furnaces a day.
 - c. Would you say that systems that have higher efficiency ratios than other systems will always have higher utilization ratios than those other systems? Explain.
2. In a job shop, effective capacity is only 50 percent of design capacity, and actual output is 80 percent of effective output. What design capacity would be needed to achieve an actual output of eight jobs per week?
3. A producer of pottery is considering the addition of a new plant to absorb the backlog of demand that now exists. The primary location being considered will have fixed costs of \$9,200 per month and variable costs of 70 cents per unit produced. Each item is sold to retailers at a price that averages 90 cents.
 - a. What volume per month is required in order to break even?
 - b. What profit would be realized on a monthly volume of 61,000 units? 87,000 units?
 - c. What volume is needed to obtain a profit of \$16,000 per month?
 - d. What volume is needed to provide a revenue of \$23,000 per month?

Operations Tours

These provide a simple “walkthrough” of an operation for students, describing the company, its product or service, and its process of managing operations. Companies featured include Wegmans Food Markets, Morton Salt, Stickley Furniture, and Boeing.

Bruegger's Bagel Bakery

OPERATIONS TOUR



Bruegger's Bagel Bakery makes and sells a variety of bagels, including plain, onion, poppyseed, and cinnamon raisin, as well as assorted flavors of cream cheese. Bagels are the major source of revenue for the company.

The bagel business is a \$3 billion industry. Bagels are very popular with consumers. Not only are they relatively low in fat, they are filling, and they taste good! Investors like the bagel industry because it can be highly profitable: it only costs about \$.10 to make a bagel, and they can be sold for \$.50 each or more. Although some bagel companies have done poorly in recent years, due mainly to poor management, Bruegger's business is booming; it is number one nationally, with over 450 shops that sell bagels, coffee, and bagel sandwiches for takeout or on-premise consumption. Many stores in the Bruegger's chain generate an average of \$800,000 in sales annually.

Production of bagels is done in batches, according to flavor, with

output at each step in the process. At the stores, employees are instructed to watch for deformed bagels and to remove them when they find them. (Deformed bagels are returned to a processing plant where they are sliced into bagel chips, packaged, and then taken back to the stores for sale, thereby reducing the scrap rate.) Employees who work in the stores are carefully chosen and then trained so that they are competent to operate the necessary equipment in the stores and to provide the desired level of service to customers.

The company operates with minimal inventories of raw materials and inventories of partially completed bagels at the plant and very little inventory of bagels at the stores. One reason for this is to maintain a high degree of freshness in the final product by continually supplying fresh product to the stores. A second reason is to keep costs down; minimal inventories mean less space is needed for storage.

ons

ger s maintains relatively little inventory at either its plants or retail stores. List the benefits and risks of this policy. Why is very important to Bruegger's. What features of bagels do customers look at to judge their quality?

Harvey Industries

CASE



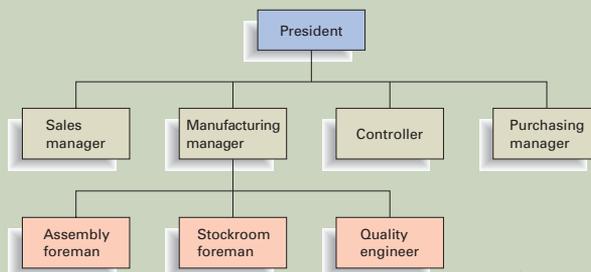
Background

Harvey Industries, a Wisconsin company, specializes in the assembly of high-pressure washer systems and in the sale of repair parts for these systems. The products range from small portable high-pressure washers to large industrial installations for snow removal from vehicles stored outdoors during the winter months. Typical uses for high-pressure water cleaning include:

| | |
|----------------------|------------------|
| Automobiles | Airplanes |
| Building maintenance | Barns |
| Engines | Ice cream plants |
| Lift trucks | Machinery |
| Swimming pools | |

Industrial customers include General Motors, Ford, Chrysler, Delta Airlines, United Parcel Service, and Shell Oil Company.

Although the industrial applications are a significant part of its sales, Harvey Industries is primarily an assembler of equipment for coin-operated self-service car wash systems. The typical car wash is of concrete block construction with an equipment room in the center, flanked on either side by a number of bays. The cars are driven into the bays where the owner can wash and wax the car, utilizing high-pressure hot water and liquid wax. A dollar bill changer is available to provide change for the use of the equipment and the purchase of various products from dispensers. The products include towels, tire cleaner, and upholstery cleaner.



Cases

The text includes short cases. The cases were selected to provide a broader, more integrated thinking opportunity for students without taking a full case approach.

INSTRUCTOR RESOURCES

Online Learning Center (OLC) www.mhhe.com/stevenson12e

The Online Learning Center provides complete materials for study and review. At this book's website, instructors have access to teaching supports such as electronic files of the ancillary materials: Solutions Manual, Instructor's Manual, test bank, PowerPoint Lecture Slides, Digital Image Library, and Excel Lecture scripts.

Instructor's Manual. Prepared by Michael Godfrey, University of Wisconsin-Oshkosh, with contributions from William J. Stevenson, this manual includes teaching notes, chapter overview, an outline for each chapter, and solutions to the problems in the text.

Test Bank. Prepared by the Alan Cannon, University of Texas-Arlington, the Test Bank includes over 2,000 true/false, multiple-choice, and discussion questions/problems at varying levels of difficulty.

EZ Test Online. All test bank questions are available in EZ Test Online, a flexible electronic testing program. The answers to all questions are given, along with a rating of the level of difficulty, chapter learning objective met, Bloom's taxonomy question type, and the AACSB knowledge category.



PowerPoint Lecture Slides. Prepared by David Cook, Old Dominion University, the PowerPoint slides draw on the highlights of each chapter and provide an opportunity for the instructor to emphasize the key concepts in class discussions.

Digital Image Library. All the figures in the book are included for insertion in PowerPoint slides or for class discussion.

Excel Lecture Scripts. Prepared by Lee Tangedahl, University of Montana, the scripts provide suggestions on using Excel and the Excel templates in class.

Operations Management Video Series

The operations management video series, free to text adopters, includes professionally developed videos showing students applications of key manufacturing and service topics in real companies. Each segment includes on-site or plant footage, interviews with company managers, and focused presentations of OM applications in use to help the companies gain competitive advantage. Companies such as Zappos, FedEx, Subaru, Disney, BP, Chase Bank, DHL, Louisville Slugger, McDonald's, Noodles & Company, and Honda are featured.

STUDENT RESOURCES

Online Learning Center (OLC) www.mhhe.com/stevenson12e

Students have access to study materials created specifically for the text.

- Quizzes—self-grading to assess knowledge of the material.
- PowerPoint Slides—give an overview of the chapter content.
- Excel Data Files—import into Excel for quick calculation and analysis.
- Study Outlines—provide a framework for taking notes.
- Screencam Tutorials—describe how to solve problems in the text (see below).

- Excel Templates—provide a handy Excel-based tool for solving problems in the text (see below).
- And more . . .



SCREENCAM TUTORIAL

ScreenCam Tutorials

These screen “movies” and voiceover tutorials explain key chapter content, using Excel and other software platforms.

Trend-Adjusted Exponential Smoothing

A variation of simple exponential smoothing can be used when a time series exhibits a *linear* trend. It is called **trend-adjusted exponential smoothing** or, sometimes, *double smoothing*, to differentiate it from simple exponential smoothing, which is appropriate only when data vary around an average or have step or gradual changes. If a series exhibits trend, and simple smoothing is used on it, the forecasts will all lag the trend: If the data are increasing, each forecast will be too low; if decreasing, each forecast will be too high.

The trend-adjusted forecast (TAF) is composed of two elements: a smoothed error and a trend factor.

$$TAF_{t+1} = S_t + T_t \quad (3-11)$$

where

S_t = Previous forecast plus smoothed error

T_t = Current trend estimate

and

$$S_t = TAF_t + \alpha(A_t - TAF_t)$$

$$T_t = T_{t-1} + \beta(TAF_t - TAF_{t-1} - T_{t-1}) \quad (3-12)$$

Trend-adjusted exponential smoothing Variation of exponential smoothing used when a time series exhibits a linear trend.



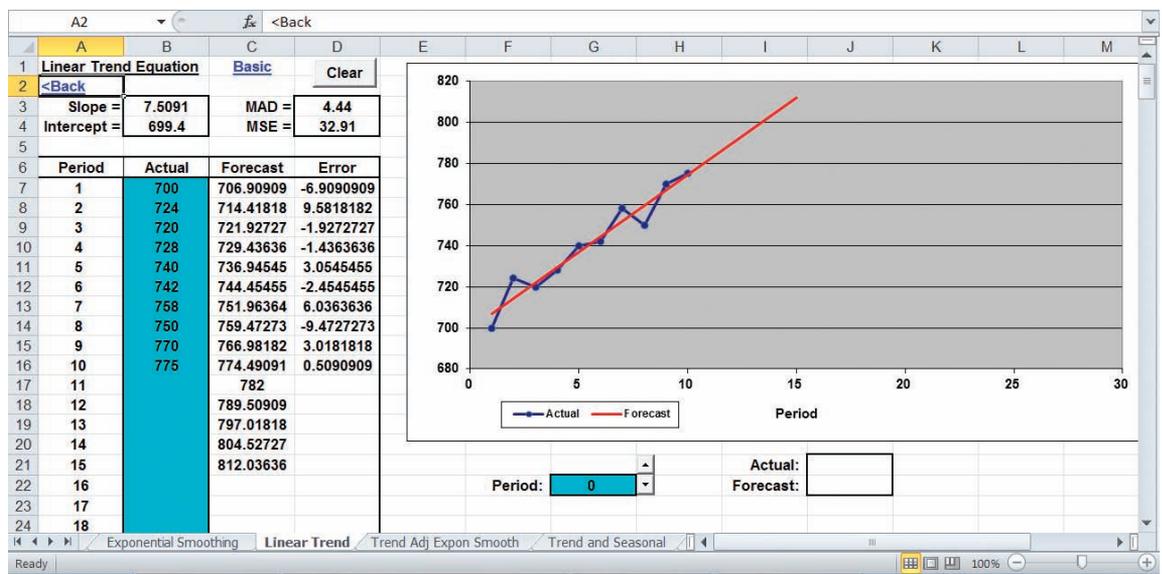
SCREENCAM TUTORIAL

LO3.12 Prepare a trend-adjusted exponential smoothing forecast.

Excel Templates

Templates created by Lee Tangedahl, University of Montana, are included on the OLC. The templates, over 70 total, include dynamically linked graphics and variable controls. They allow you to solve a number of problems in the text or additional problems. All templates have been revised to allow formatting of all cells, hiding rows or columns, and entering data or calculations in blank cells. Many of the templates have been expanded to accommodate solving larger problems and cases.

TABLE 3.1 Excel solution for Example 5



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E-LEARNING AND ASSESSMENT

McGraw-Hill Connect® Operations Management

McGraw-Hill Connect® Operations Management is an online assignment and assessment solution that connects students with the tools and resources they'll need to achieve success through faster learning, higher retention, and more efficient studying. It provides instructors with tools to quickly pick content and assignments according to the topics they want to emphasize.



Online Assignments. Connect Operations Management helps students learn more efficiently by providing practice material and feedback when they are needed. Connect grades homework automatically and provides feedback on any questions that students may have missed.

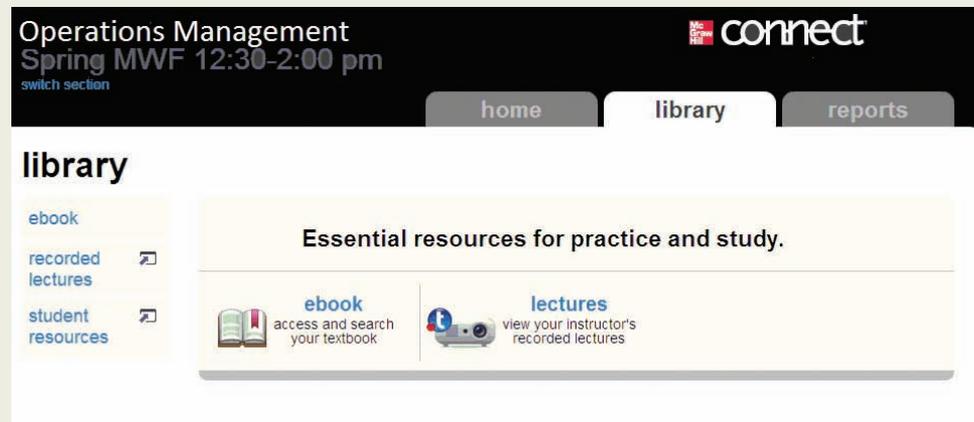
The screenshot displays the McGraw-Hill Connect interface for Operations Management, Section 1. The top navigation bar includes 'Home', 'Library', and 'Reports'. The main content area is divided into several sections:

- Messages:** Shows 'No assignments to grade'.
- Assignments:** A table listing assignments with columns for Title, Shared, Info, Start-due, and Show/hide. The assignments listed are:

| Title | Shared | Info | Start-due | Show/hide |
|-------------------------|--------|------|-------------------|-----------|
| Assignment 1 - Homework | | | 10/25/13- none | |
| Quiz 1 | | | 10/25/13- none | |
| Test 1 | | | 10/25/13- none | |
- Section info:** Displays the instructor's name, Thomas Hayward, and email address, Hayward@bschool.edu.
- Textbook:** Shows the textbook title 'Operations Management' by Stevenson, 12th ed., and the section web address: <http://connect.mcgraw-hill.com/class/w>.

Integration of Excel Data Sets. A convenient feature is the inclusion of an Excel data file link in many problems using data files in their calculation. The link allows students to easily launch into Excel, work the problem, and return to Connect to key in the answer.

Student Resource Library. The *Connect Business Statistics* Student Library is the place for students to access additional resources. The Student Library provides quick access to recorded lectures, practice materials, eBooks, and more.



Guided Examples. These narrated video walkthroughs provide students with step-by-step guidelines for solving problems similar to those contained in the text. The student is given personalized instruction on how to solve a problem by applying the concepts presented in the chapter. The narrated voiceover shows the steps to take to work through an exercise. Students can go through each example multiple times if needed.



LearnSmart. LearnSmart adaptive self-study technology with *Connect Operations Management* helps students make the best use of their study time. LearnSmart provides a seamless combination of practice, assessment, and remediation for every concept in the textbook. LearnSmart's intelligent software adapts to students by supplying questions on a new concept when students are ready to learn it. With LearnSmart students will spend less time on topics they understand and instead focus on the topics they need to master.

Simple Assignment Management and Smart Grading. When it comes to studying, time is precious. *Connect Operations Management* helps students learn more efficiently by providing feedback and practice material when they need it, where they need it. When it comes to teaching, your time also is precious. The grading function enables you to:

- Have assignments scored automatically, giving students immediate feedback on their work and side-by-side comparisons with correct answers.
- Access and review each response; manually change grades or leave comments for students to review.

Student Reporting. *Connect Operations Management* keeps instructors informed about how each student, section, and class is performing, allowing for more productive use of lecture and office hours. The progress-tracking function enables you to:

- View scored work immediately (Add Assignment Results Screen) and track individual or group performance with assignment and grade reports.
- Access an instant view of student or class performance relative to learning objectives.
- Collect data and generate reports required by many accreditation organizations, such as AACSB.

Operations Management
Section One: MWF 11:30-1:30
switch section

connect

home library reports

assignment results

report type: Assignment Results

Use the options below to view assignment scores.

[show report options & settings](#)

assignment results: Multiple Sections
report created: 09/09/2012 9:57 AM CDT
report date range: -
attempt: Best **score style:** Percents (Averaged)
assignment type: Homework, Practice, Quiz, Exam

Select the checkboxes on columns you want to export or print.

export to excel

| Section | <input checked="" type="checkbox"/> Assignment 1 | <input checked="" type="checkbox"/> Assignment 2 | <input checked="" type="checkbox"/> Exam 1 |
|---|--|--|--|
| Total Value (Points) | 20 | 25 | 20 |
| Townsend, Rachel Section One: MWF 1:30-3:30 | 89% | 91.50% | 89% |
| Mann, Becky Section One: MWF 1:30-3:30 | 85.33% | 93% | 85% |
| Dalo, Danielle Section One: MWF 1:30-3:30 | 89% | 91.50% | 91% |
| Billows, Nancy Section One: MWF 1:30-3:30 | 85.33% | 93% | 93% |

Instructor Library. The *Connect Operations Management* Instructor Library is your repository for additional resources to improve student engagement in and out of class. You can select and use any asset that enhances your lecture. The *Connect Business Statistics* Instructor Library includes:

- eBook
- PowerPoint presentations

connect

Operations Management
Section 1

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library

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ebook

Operations Management

Chapter 4. Product and Service Design

reading images [my notebook](#)

Chapter 4 Sections

4.1 INTRODUCTION

This section discusses what product and service designers do, the reasons for design (or redesign), and key questions that management must address.

What Does Product and Service Design Do?

The various activities and responsibilities of product and service design include the following (functional interactions are shown in parentheses):

1. Translate customer wants and needs into product and service requirements. (marketing, operations)
2. Refine existing products and services. (marketing)
3. Develop new products and/or services. (marketing, operations)
4. Formulate quality goals. (marketing, operations)
5. Formulate cost targets. (accounting, finance, operations)
6. Construct and test prototypes. (operations, marketing, engineering)
7. Document specifications.
8. Translate product and service specifications into *process* specifications. (engineering, operations)

Product and service design involves or affects nearly every functional area of an organization. However, marketing and operations have major involvement.

Key Questions

Operations Management
Stevenson, 12e

L04.2 Describe what product and service design does.

- Test Bank
- Instructor's Manual
- Digital Image Library



Connect® Plus Operations Management includes a seamless integration of an eBook and *Connect Operations Management* with rich functionality integrated into the product.

Integrated Media-Rich eBook. An integrated media-rich eBook allows students to access media in context with each chapter. Students can highlight, take notes, and access shared instructor highlights/notes to learn the course material.

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Tegrity Campus is a service that makes class time available 24/7 by automatically capturing every lecture in a searchable format for students to review when they study and complete assignments. With a simple one-click start-and-stop process, you capture all computer screens and corresponding audio. Students can replay any part of any class with easy-to-use browser-based viewing on a PC or Mac.

Educators know that the more students can see, hear, and experience class resources, the better they learn. In fact, studies prove it. With *Tegrity Campus*, students quickly recall key moments by using *Tegrity Campus*'s unique search feature. This search helps students efficiently find what they need, when they need it, across an entire semester of class recordings. Help turn all your students' study time into learning moments immediately supported by your lecture. To learn more about *Tegrity*, watch a two-minute Flash demo at <http://tegritycampus.mhhe.com>.



Online Course Management

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ASSURANCE OF LEARNING READY



Many educational institutions today are focused on the notion of *assurance of learning*, an important element of some accreditation standards. *Operations Management* is designed specifically to support your assurance of learning initiatives with a simple, yet powerful, solution.

Each test bank question for *Operations Management* maps to a specific chapter learning outcome/objective listed in the text. You can use our test bank software, EZ Test and EZ Test Online, or Connect *Operations Management* to easily query for learning outcomes/objectives that directly relate to the learning objectives for your course. You can then use the reporting features of EZ Test to aggregate student results in similar fashion, making the collection and presentation of assurance of learning data simple and easy.

AACSB STATEMENT



McGraw-Hill Education is a proud corporate member of AACSB International. Understanding the importance and value of AACSB accreditation, *Operations Management* recognizes the curricula guidelines detailed in the AACSB standards for business accreditation by connecting selected questions in the test bank to the six general knowledge and skill areas in the AACSB's Assessment of Learning Standards.

The statements contained in *Operations Management* are provided only as a guide for the users of this textbook. The AACSB leaves content coverage and assessment within the purview of individual schools, the mission of the school, and the faculty. While *Operations Management* and the teaching package make no claim of any specific AACSB qualification or evaluation, we have within the test bank labeled questions according to the six general knowledge and skill areas.

Note to Students

The material in this text is part of the core knowledge in your education. Consequently, you will derive considerable benefit from your study of operations management, *regardless of your major*. Practically speaking, operations is a course in *management*.

This book describes principles and concepts of operations management. You should be aware that many of these principles and concepts are applicable to other aspects of your professional and personal life. You can expect the benefits of your study of operations management to serve you in those other areas as well.

Some students approach this course with apprehension, and perhaps even some negative feelings. It may be that they have heard that the course contains a certain amount of quantitative material that they feel uncomfortable with, or that the subject matter is dreary, or that the course is about “factory management.” This is unfortunate, because the subject matter of this book is interesting and vital for all business students. While it is true that some of the material is quantitative, numerous examples, solved problems, and answers at the back of the book will help you with the quantitative material. As for “factory management,” there is material on manufacturing as well as on services. Manufacturing is important, and something that you should know about for a number of reasons. Look around you. Most of the “things” you see were manufactured: cars, trucks, planes, clothing, shoes, computers, books, pens and pencils, desks, and cell phones. And these are just the tip of the iceberg. So it makes sense to know something about how these things are produced. Beyond all that is the fact that manufacturing is largely responsible for the high standard of living people have in industrialized countries.

After reading each chapter or supplement in the text, attending related classroom lectures, and completing assigned questions and problems, you should be able to do each of the following:

1. *Identify the key features* of that material.
2. *Define and use terminology*.
3. *Solve typical problems*.

4. *Recognize applications* of the concepts and techniques covered.
5. *Discuss the subject matter* in some depth, including its relevance, managerial considerations, and advantages and limitations.

You will encounter a number of chapter supplements. Check with your instructor to determine whether to study them.

This book places an emphasis on problem solving. There are many examples throughout the text illustrating solutions. In addition, at the end of most chapters and supplements you will find a group of solved problems. The examples within the chapter itself serve to illustrate concepts and techniques. Too much detail at those points would be counterproductive. Yet, later on, when you begin to solve the end-of-chapter problems, you will find the solved problems quite helpful. Moreover, those solved problems usually illustrate more and different details than the problems within the chapter.

I suggest the following approach to increase your chances of getting a good grade in the course:

1. Look over the chapter outline and learning objectives.
2. Read the chapter summary, and then skim the chapter.
3. Read the chapter and take notes.
4. Look over and try to answer the discussion and review questions.
5. Solve the problems, referring to the solved problems and chapter examples as needed.
6. Take the quizzes on the text’s website.

Note that the answers to many problems are given at the end of the book. Try to solve each problem before turning to the answer. Remember—tests don’t come with answers.

An Online Learning Center (www.mhhe.com/stevenson12e) is also available, containing many of the same study tools found in the text.

And here is one final thought: Homework is on the Highway to Happiness! Enjoy the journey!

W.J.S.

Chapter-by-Chapter Revisions for the Twelfth Edition

All Chapters

Major sections within each chapter are numbered for easy reference.

Learning objectives are positioned with related content within each chapter.

Many minor changes have been made to improve clarity and understanding.

The Bibliography & Additional Reading sections have been updated/reviced.

Most Chapters

Learning Objectives have been revised to incorporate new content. Questions have been added to some readings that did not have questions.

Additional Changes

Chapter 1: Updated product examples to make them more current; changed the sequence of some content; updated the reading on why manufacturing matters; added operations management job descriptions; added new readings on analytics and agility; and added a format to guide problem solving.

Chapter 2: Added examples of Balanced Scorecard factors; added new reading on productivity advantage; and added the USPS sustainability scorecard to the USPS reading

Chapter 3: Added a simpler example to illustrate seasonal computations; revised Discussion and Review question 4; revised problems 2, 5, and 23; renumbered problems 8-18; added new problem 13.

Chapter 4: Added a reading; added several Discussion and Review Questions; and updated Problem 1.

Chapter 5: Added formula (and renumbered the formulas); added a new example; added a new Solved Problem; added a new Critical Thinking Exercise; and added five new problems.

Chapter 6: Modified the introduction to process selection and the figure that relates volume and variety to process type; added content on RFID tags; added a reading and deleted two readings; added material on restaurant and hospital layouts and a reading on the hospital room of the future; and added a Critical Thinking Exercise.

Chapter 7: Changed the sequence of topics slightly to improve the flow; shortened the chapter by deleting a few lists

and a table; add a solved problems and three new problems; and provided additional guidance in the use of several formulas.

Chapter 8: Added content on automation; added a reading and deleted several readings; and moved the Clicks or Bricks reading to the supply chain chapter.

Chapter 8S: This supplement has been moved to the Online Learning Center.

Chapter 9: Rearranged the sequence of some topics to improve the flow; shortened the chapter; Deleted several readings; and added material on Six Sigma.

Chapter 10: Modified several diagrams to improve understanding; added a Critical Thinking Exercise; and modified the formula summary table to make it easier to select the appropriate formula.

Chapter 10S: This supplement has been moved to the Online Learning Center.

Chapter 11: Added more explanation of aggregation; added three new problems and renumbered some problems; and added an excel screenshot.

Chapter 12: Revised the introduction completely; added detail to the starting tree diagram; added new material on ERP, including a new figure; added a setup guide for developing an MRP plan; added a new solved problem and a new problem; and deleted the last part of problem 9.

Chapter 13: Revised the chapter opening material; updated Example 3; added more explanation of the EPQ model; and added a new problem 1 and revised problems 2, 11, 27 and 28.

Chapter 14: Added a description of the characteristics of lean systems; added benefits and risks of lean systems; deleted a reading; added a reading; and added more material on value stream mapping.

Chapter 15: Added new sections on risk and resiliency, shortening the supply chain, and small businesses; added a new reading; added material on ERP and the supply chain; added some material on CPF and SCORE; and added the Clicks and Bricks reading from chapter 8.

Chapter 16: Added some excel screen shots for clarity.

Chapter 17: Revised the description of project cycle and definition of terms; added a new Solved Problem; revised problems so they can be solved using either AOA or AON.

Chapter 18: Deleted readings on hotels and waiting at stop lights; added some starter problems.

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