

ELEVENTH EDITION

OPERATIONS MANAGEMENT

Sustainability and Supply Chain Management



JAY
HEIZER

BARRY
RENDER

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JAY
HEIZER

Jesse H. Jones Professor of Business Administration
Texas Lutheran University

BARRY
RENDER

Charles Harwood Professor of Operations Management
Graduate School of Business
Rollins College

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To Kathryn Ann Heizer

J.H.

**To Donna, Charlie, Jesse, and Reva
and to Howard G. Kornacki, the teacher who taught me to love math**

B.R.

★ ABOUT THE ★ AUTHORS

JAY HEIZER



Professor Emeritus, the Jesse H. Jones Chair of Business Administration, Texas Lutheran University, Seguin, Texas. He received his B.B.A. and M.B.A. from the University of North Texas and his Ph.D. in Management and Statistics from Arizona State University. He was previously a member of the faculty at the University of Memphis, the University of Oklahoma, Virginia Commonwealth University, and the University of Richmond. He has also held visiting positions at Boston University, George Mason University, the Czech Management Center, and the Otto-Von-Guericke University, Magdeburg.

Dr. Heizer's industrial experience is extensive. He learned the practical side of operations management as a machinist apprentice at Foringer and Company, as a production planner for Westinghouse Airbrake, and at General Dynamics, where he worked in engineering administration. In addition, he has been actively involved in consulting in the OM and MIS areas for a variety of organizations, including Philip Morris, Firestone, Dixie Container Corporation, Columbia Industries, and Tenneco. He holds the CPIM certification from APICS—the Association for Operations Management.

Professor Heizer has co-authored 5 books and has published more than 30 articles on a variety of management topics. His papers have appeared in the *Academy of Management Journal*, *Journal of Purchasing*, *Personnel Psychology*, *Production & Inventory Control Management*, *APICS—The Performance Advantage*, *Journal of Management History*, *IIE Solutions*, and *Engineering Management*, among others. He has taught operations management courses in undergraduate, graduate, and executive programs.

BARRY RENDER



Professor Emeritus, the Charles Harwood Professor of Operations Management, Crummer Graduate School of Business, Rollins College, Winter Park, Florida. He received his B.S. in Mathematics and Physics at Roosevelt University, and his M.S. in Operations Research and Ph.D. in Quantitative Analysis at the University of Cincinnati. He previously taught at George Washington University, University of New Orleans, Boston University, and George Mason University, where he held the Mason Foundation Professorship in Decision Sciences and was Chair of the Decision Sciences Department. Dr. Render has also worked in the aerospace industry for General Electric, McDonnell Douglas, and NASA.

Professor Render has co-authored 10 textbooks for Prentice Hall, including *Managerial Decision Modeling with Spreadsheets*, *Quantitative Analysis for Management*, *Service Management*, *Introduction to Management Science*, and *Cases and Readings in Management Science*. *Quantitative Analysis for Management*, now in its 11th edition, is a leading text in that discipline in the United States and globally. Dr. Render's more than 100 articles on a variety of management topics have appeared in *Decision Sciences*, *Production and Operations Management*, *Interfaces*, *Information and Management*, *Journal of Management Information Systems*, *Socio-Economic Planning Sciences*, *IIE Solutions*, and *Operations Management Review*, among others.

Dr. Render has been honored as an AACSB Fellow and was twice named a Senior Fulbright Scholar. He was Vice President of the Decision Science Institute Southeast Region and served as Software Review Editor for *Decision Line* for six years and as Editor of the *New York Times* Operations Management special issues for five years. From 1984 to 1993, Dr. Render was President of Management Service Associates of Virginia, Inc., whose technology clients included the FBI, the U.S. Navy, Fairfax County, Virginia, and C&P Telephone. He is currently Consulting Editor to *Financial Times Press*.

Dr. Render has taught operations management courses in Rollins College's MBA and Executive MBA programs. He has received that school's Welsh Award as leading Professor and was selected by Roosevelt University as the 1996 recipient of the St. Claire Drake Award for Outstanding Scholarship. In 2005, Dr. Render received the Rollins College MBA Student Award for Best Overall Course, and in 2009 was named Professor of the Year by full-time MBA students.

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Preface

Welcome to your operations management (OM) course. In this book, we present a state-of-the-art view of the operations function. Operations is an exciting area of management that has a profound effect on productivity. Indeed, few other activities have as much impact on the quality of our lives. The goal of this text is to present a broad introduction to the field of operations in a realistic, practical manner. Even if you are not planning on a career in the operations area, you will likely be working with people in operations. Therefore, having a solid understanding of the role of operations in an organization will be of substantial benefit to you. This book will also help you understand how OM affects society and your life. Certainly, you will better understand what goes on behind the scenes when you attend a concert or major sports event; purchase a bag of Frito-Lay potato chips; buy a meal at an Olive Garden or a Hard Rock Cafe; place an order through Amazon.com; buy a customized Dell computer over the Internet; or enter a hospital for medical care. More than 1 million readers of our earlier editions seem to have endorsed this premise.

We welcome comments by email from our North American readers and from students using the EU Global edition, the Indian edition, and our editions in Portuguese, Spanish, Turkish, Indonesian, and Chinese. Hopefully, you will find this material useful, interesting, and even exciting.

New to This Edition

We've made significant revisions to this edition, and want to share some of the changes with you.

Emphasis on Sustainability and Supply-Chain Management Integration

This edition has a new title, *Operations Management: Sustainability and Supply Chain Management*, reflecting significant new material on these important aspects of OM. Not only have we added new material on supply chains throughout the book, but three chapters now deal specifically with the topics:

- ▶ *New chapter called “Sustainability in the Supply Chain”*: Supplement 5 is an all-new chapter, created by Professor Steve Leon of the University of Central Florida, that focuses on the central OM issue of sustainability and corporate social responsibility. We introduce the three Rs of sustainability and mathematical models for revenue “design for disassembly” and life cycle costing. There are also two video case studies: “Building Sustainability at the Orlando Magic’s Amway Center” and “Green Manufacturing and Sustainability at Frito-Lay.” Sustainability has also been integrated throughout the text, where appropriate.
- ▶ *Significant revision of Chapter 11, “Supply Chain Management”*: This chapter, the heart of our supply chain coverage, provides added emphasis on the topic, with new examples, graphs, tables, and problems. The chapter has sections that explain (1) the impact of corporate strategy on supply chain decisions, (2) the relationship between supply chain strategy and sales strategy, (3) supply chain risks, (4) supplier evaluation and contracts, (5) distribution management, (6) sustainability in supply chains, and (7) the SCOR model. We believe that this new organization will appeal to students and instructors with its flow and clarity.
- ▶ *New chapter called “Supply Chain Analytics”*: Supplement 11 is a new chapter, written by Professor Chuck Munson of Washington State University, that also expands our supply chain coverage by addressing four analytic approaches to evaluating supply chains: (1) disaster risk modeling, (2) management of the bullwhip effect, (3) supplier selection analysis, and (4) transportation mode analysis. The topic of *outsourcing* (which used to be the basis of Supplement 11

in the prior edition) has been moved to Chapter 2, “Operations Strategy in a Global Environment.” This is the first text to include a chapter on this important analytic material.

Five New Video Case Studies Featuring the Orlando Magic NBA Basketball Team and Orlando’s Amway Center

In this edition, we take you behind the scenes of a professional basketball team and its home arena. We provide five new *Video Case Studies* of the Orlando Magic and its home, the Amway Center, as well as photos, examples, and problems. This exciting organization opened its doors so we could examine OM in professional sports. We present a look at the Magic’s ticket forecasting (Chapter 4), the sustainability of its new arena (Chapter 5), its revenue management (Chapter 13), how it handles food preparation for feeding 18,500 fans (Chapter 14), and its scheduling and conversion from one event to another (Chapter 15), each in a series of 8- to 12-minute videos.

Our prior editions focused on integrated *Video Case Studies* for Frito-Lay, Darden Restaurants (Olive Garden/Red Lobster), Hard Rock Cafe, Arnold Palmer Hospital, Wheeled Coach Ambulances, and Regal Marine. These *Video Case Studies* appear in this edition as well, along with the five new ones for the Orlando Magic. All of our videos are created by the authors to explicitly match with text content and terminology.

★ Building Sustainability at the Orlando Magic’s Amway Center

Video Case 

When the Amway Center opened in Orlando in 2011, it became the first LEED (Leadership in Energy and Environmental Design) gold-certified professional basketball arena in the country. It took 10 years for Orlando Magic’s management to develop a plan for the new state-of-the-art sports and entertainment center. The community received not only an entertainment center but an environmentally sustainable building to showcase in its revitalized downtown location. “We wanted to make sure we brought the most sustainable measures to the construction, so in operation we can be a good partner to our community and our environment,” states CEO Alex Martins. The new 875,000-square foot facility—almost triple the size of the Amway Arena it replaced—is now the benchmark for other sports facilities.

Here are a few of the elements in the Amway Center project that helped earn the LEED certification:

- ▶ The roof of the building is designed to minimize daytime heat gain by using reflective and insulated materials.
- ▶ Rainwater and air-conditioning condensation are captured and used for irrigation.
- ▶ There is 40% less water usage than in similar arenas (saving 800,000 gallons per year), mostly through use of high-efficiency restrooms, including low-flow, dual-flush toilets.
- ▶ There is 20% energy savings (about \$750,000 per year) with the use of high-efficiency heating and cooling systems.

Student Tips

You will notice another new feature throughout every chapter that we call *Student Tips*. Here we point out why an idea, a figure, or a table is so important. The tips are intended to be motivational to students, as well as educational.

Jay and Barry’s OM Blog

As a complement to this text, we have created a companion blog, with coordinated features to help teach the OM course. There are teaching tips, highlights of OM items in the news (along with class discussion questions and links), video tips, guest posts by instructors using our text, sample OM syllabi from dozens of colleges, and much more—all arranged by chapter. To learn more about any chapter topics, visit www.heizerrenderOM.wordpress.com.

Chapter-by-Chapter Changes

To highlight the extent of the revisions in this edition, here are a few of the changes, on a chapter-by-chapter basis. As noted above, we have added new chapters on sustainability in the supply chain and supply-chain management analytics, and we have moved the material in the previous edition’s Supplement 11, “Outsourcing,” to Chapter 2. We have also changed the titles of our six quantitative modules to *Business Analytics Modules*.

Chapter 1: Operations and Productivity

We now integrate the topic of supply chains into the text with material in Chapter 1 that sets the stage for the entire book. We have rewritten and clarified material that shows the difference between services and goods, updated job information to show how services continue to grow over manufacturing, and added a new *Ethical Dilemma* that deals with recycling used auto batteries to Mexico.

Chapter 2: Operation Strategy in a Global Environment

This chapter, which introduces OM as a global tool, has also been revised significantly to help students see strategy more succinctly. The material on core competencies, the theory of comparative advantages, and outsourcing (formerly in Supplement 11) now appears here. The factor-rating method is introduced, there are five new homework problems, and a *Video Case Study* on Darden's outsourcing is included in this chapter.

Chapter 3: Project Management

Changes in this chapter include a revised example that runs throughout the chapter and deals with the installation of pollution control equipment at a manufacturer in time for Earth Day.

Chapter 4: Forecasting

There is a new section on supply chain management, in keeping with our integration of that topic in this edition. We also created a new *Video Case Study* called "Forecasting Ticket Revenue for Orlando Magic Basketball Games" (which uses regression and multiple regression analysis), provided a more detailed explanation (in Figure 4.10) of correlation analysis, added a new *Ethical Dilemma* (which deals with SAT scores), added four new Solved Problems, provided four new homework problems on the topic of mean squared error, and revised several of the existing problems and examples.

Chapter 5: Design of Goods and Services

We are pleased that ours is the first text to provide comprehensive coverage of process-chain-network (PCN) analysis, developed and written by Professor Scott Sampson at BYU, including three homework problems. We have also added two new *OM in Action* boxes—one on 3-D printers and the other on the cell phone design frenzy. There is a new section on service efficiency, and we have moved the previous edition's discussion on sustainability to Supplement 5.

Supplement 5: Sustainability in the Supply Chain

This all-new chapter, created by Dr. Steve Leon at the University of Central Florida, deals with many aspects of sustainability in OM. Topics include corporate social responsibility, the three Rs, designing for disassembly, and regulations. Break-even analysis is used to evaluate the life cycle assessment of products, and a revenue retrieval model is provided to evaluate environmental design. Two *Video Case Studies* are provided: "Building Sustainability at the Orlando Magic's Amway Center" and "Green Manufacturing and Sustainability at Frito-Lay." There are also eight homework problems and an online case study on Walmart's sustainability endeavors.

Chapter 6: Managing Quality

We have updated our treatment of ISO 9000, added a feature on control charts for the Orlando Magic free-throws, included new material on checklists, added a new *OM in Action* box on hospital safety, provided an interesting analysis of quality standards at Alaska Airlines, and added a new Solved Problem on Pareto charts.

Supplement 6: Statistical Process Control

This supplement includes the new *OM in Action* "Trying to Land a Seat with Frequent Flyer Miles" and a new Solved Problem that describes *c*-charts.

Chapter 7: Process Strategy

This chapter is shorter, with the material on sustainability revamped and provided in the new Supplement 5. We have also made the material on process choices more concise and added a new *OM in Action* box on how iPads are being used in restaurants for ordering.

Supplement 7: Capacity and Constraint Management

A new example of economies of scale uses Krispy Kreme as its basis. We also added a new *OM in Action* box on how airlines match capacity to demand and provided a fourth approach to capacity expansion. The major change is a new treatment of bottlenecks and throughput time, including some new terminology, a rewritten Example 3 on capacity analysis with parallel processes, and revised homework problems.

Chapter 8: Location Strategies

We have added a discussion of the concept of aerotropolis, an airport integration region as part of the economics of location, changed our terminology from *locational break-even analysis* to *locational cost–volume analysis*, added an Excel spreadsheet example of how to solve a center-of-gravity problem, and provided a new Solved Problem on that topic. There are two new *OM in Action* boxes: one on Otis Elevator’s decision to leave Mexico and return to the U.S. and the second on how La Quinta Motor Inns uses regression analysis for site selection.

Chapter 9: Layout Strategies

In this chapter, we updated our discussion of office layout and workspaces, including the new *OM in Action* box “Layout and the Shrinking Office.” The chapter also has new material on Factory Flow software, a revised example (Example 4) of line balancing, new presentation of idle time and efficiency, and a new homework problem. We have also rewritten the material on focused factories and focused work centers.

Chapter 10: Human Resources, Job Design, and Work Measurement

This chapter sports a new look with six new photos and a revised *Ethical Dilemma*.

Chapter 11: Supply Chain Management

This chapter has undergone a major revision, in keeping with our increased emphasis on supply chains in this edition. There are new tables, examples, and topics (such as supply-chain risk, supplier certification, contracting, centralized purchasing, multimodal distribution systems, warehousing, distribution management, sustainability, ethics, and the SCOR model). The chapter also has a new *Ethical Dilemma* and two new homework problems.

Supplement 11: Supply Chain Management Analytics

This all-new chapter, written by Professor Chuck Munson at Washington State University, illustrates the important role of metrics in building and evaluating performance of the supply chain. Decision trees are introduced as a tool for evaluating disaster risk, the bullwhip effect is calculated with an analytic measure, suppliers are evaluated by the factor rating method, and shipping options are compared with transportation mode analysis (the latter two topics moved from Chapter 11 to this supplement). There are nine new homework problems and three new Solved Problems. Ours is the first text to publish all these analytic measures and bring them together in a way that is easily teachable for instructors who wish to delve into the topic.

Chapter 12: Inventory Management

We have updated the *Global Company Profile* highlighting [Amazon.com](https://www.amazon.com), added new material on record accuracy, introduced safety stock into the reorder point model (Example 7), included a new *OM in Action* box dealing with control of service inventories, and provided a new case study.

Chapter 13: Aggregate Planning and S&OP

This edition sees a refocus around the topic of sales and operations planning (S&OP). The short discussions of the management coefficients model and LDR have been removed, but we have expanded the treatment of revenue (yield) management. Our new *Video Case Study*, “Using Revenue Management to Set Orlando Magic Ticket Prices,” replaces the Southwestern University: G case, which now appears on our Web site.

Chapter 14: Material Requirements Planning (MRP) and ERP

We have revised our section on MRP and JIT with a more succinct treatment of MRP limitations, and we have replaced the part period balancing model with the periodic order quantity (POQ) lot-sizing technique. We also now showcase the Orlando Magic’s Chef John Nicely, with (1) a master production schedule for macaroni and cheese (Table 14.1), (2) a product structure tree and bill of materials for that dish (Figure 14.9), and (3) our new *Video Case Study* “When 18,500 Orlando Magic Fans Come to Dinner.” In addition, we added five new homework problems.

Chapter 15: Short-Term Scheduling

This chapter has undergone a revision to help students focus on the basics of scheduling. Introductory material has been shortened, and the topic of scheduling repetitive facilities has been moved to Chapter 16. We have added a new *OM in Action* box to Chapter 15: “Prepping for the Orlando Magic Basketball Game.” In addition, students should enjoy our new *Video Case Study*: “From the Eagles to the Magic: Converting the Amway Center.”

Chapter 16: JIT, TPS, and Lean Operations

Reflecting additional material on Toyota Production Systems, we have added TPS to the chapter title. The chapter also has a new *OM in Action* box, “Continuous Improvement at Toyota,” and new material on sustainability. The case study “JIT After a Catastrophe” is now on our companion Web site, www.pearsonhighered.com/heizer.

Chapter 17: Maintenance and Reliability

This chapter now includes a new *Ethical Dilemma*.

Business Analytics Module A: Decision Making Tools

We have revised the Getz Products example that runs throughout this module so that the probabilities of a favorable and unfavorable market now differ. Professor Tallys Yunes, at the University of Miami, contributed a new case study, “Warehouse Tenting at the Port of Miami,” that replaces “Tom Tucker’s Liver Transplant” (which now appears on our companion Web site, www.pearsonhighered.com/heizer).

Business Analytics Module B: Linear Programming

This module has a new *OM in Action* box called “LP at UPS” and a new homework problem that uses LP in project crashing. Several other problems and the case study have been revised.

Business Analytics Module C: Transportation Models

We have shortened this module by deleting some of our detailed coverage of unbalanced problems and degeneracy.

Business Analytics Module D: Waiting-Line Models

We have changed the terminology in this module to refer to queue designs as *single server* or *multiple server* instead of *single channel* and *multi-channel*.

Business Analytics Module E: Learning Curves

We now open this module with two side-by-side learning curve graphs (exponential and log-log), have added new material on Boeing’s learning curves for its 787 model, have included a new example of how to compute learning rate from observed production, and have added one homework problem.

Business Analytics Module F: Simulation

This module is now briefer, with two of the longer simulation examples removed. All the basics needed to develop and solve a variety of simulation problems remain intact.

Student Resources

To liven up the course and help students learn the content material, we have made available the following resources:

- ▶ *Thirty-six exciting Video Case Studies* (located on the *Operations Management DVD Library*, ISBN: 0-13-286332-4, and at www.myomlab.com): These *Video Case Studies* feature real companies (The Orlando Magic, Frito-Lay, Darden Restaurants, Regal Marine, Hard Rock Cafe, Ritz-Carlton, Wheeled Coach, and Arnold Palmer Hospital) and allow students to watch short videos, read about the key topics, and answer questions. These case studies can also be assigned

without using class time to show the videos. Each of them was developed and written by the text authors to specifically supplement the book's content.

- ▶ *DVD video clips (located on the Operations Management DVD Library, ISBN: 0-13-286332-4, and at www.myomlab.com):* We have provided 37 1- to 2-minute video clips to illustrate chapter-related topics with videos at Frito-Lay, Harley-Davidson, Ritz-Carlton, Hard Rock Cafe, Olive Garden, and other firms.
- ▶ *POM for Windows software:* POM for Windows is a powerful tool for easily solving OM problems. Its 24 modules can be used to solve most of the homework problems in the text. POM for Windows software is available on the student CD that accompanies new copies of the text. The *Student CD*, ISBN: 0-13-340156-1, can be purchased separately. The software is also available for download at www.myomlab.com.
- ▶ *Excel OM problem-solving software:* Excel OM is our exclusive user-friendly Excel add-in. Excel OM automatically creates worksheets to model and solve problems. Users select a topic from the pull-down menu and fill in the data, and then Excel will display and graph (where appropriate) the results. This software is great for student homework, what-if analysis, and classroom demonstrations. This edition includes a new version of Excel OM that is compatible with Microsoft Excel 2010 as well as earlier versions of Excel. Excel OM problem-solving software is available on the Student CD that accompanies new copies of the text. The *Student CD*, ISBN: 0-13-340156-1, can be purchased separately. The software is also available for download at www.myomlab.com. Professor Howard Weiss, Temple University, developed both Excel OM and POM for Windows to accompany our text and its problem set.
- ▶ *Excel OM data files:* These data files are prepared for specific examples and allow users to solve all the marked text examples without reentering any data. The Excel OM data files are available for download at the *Companion Web site*, www.pearsonhighered.com/heizer, and at www.myomlab.com.
- ▶ *Active Models:* The 28 Active Models, which are Excel-based OM simulations, are available at www.myomlab.com.
- ▶ *Virtual tours (located at www.myomlab.com and the Companion Web site, at www.pearsonhighered.com/heizer):* These company tours provide direct links to companies—ranging from a hospital to an auto manufacturer—that practice key OM concepts. After touring each Web site, students are asked questions directly related to the concepts discussed in the chapter.
- ▶ *Online Tutorial Chapters (located at www.myomlab.com and the Companion Web site, www.pearsonhighered.com/heizer):* “Statistical Tools for Managers,” “Acceptance Sampling,” “The Simplex Method of Linear Programming,” “The MODI and VAM Methods of Solving Transportation Problems,” and “Vehicle Routing and Scheduling” are provided as additional material.
- ▶ *Additional practice problems (located at www.myomlab.com and www.pearsonhighered.com/heizer):* These problems provide problem-solving experience. They supplement the examples and solved problems found in each chapter.
- ▶ *Additional case studies (located at www.myomlab.com and www.pearsonhighered.com/heizer):* Over two dozen additional case studies supplement the ones in the text. Detailed solutions appear in the Solutions Manual.
- ▶ *Virtual office hours (located at www.myomlab.com):* Professors Heizer and Render appear on MyOMLab, walking students through all 83 Solved Problems in a series of 5- to 20-minute explanations. These have been updated with this new edition.
- ▶ *Microsoft Project 2010 (ISBN 0-13-313009-6):* Microsoft Project, the most popular and powerful project management package, is now available on an additional student CD-ROM. This full version, documented in Chapter 3, is activated to work for 60 days.

Instructor Resources

Register, Redeem, Log in

At www.pearsonhighered.com/lrc instructors can register and access a variety of print, media, and presentation resources that are available with this text in downloadable digital format. For most texts, resources are also available for course management platforms such as Blackboard, WebCT, and Course Compass.

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Once you register, you will not have additional forms to fill out or multiple usernames and passwords to remember to access new titles and/or editions. As a registered faculty member, you can log in directly to download resource files and receive immediate access and instructions for installing course management content on your campus server.

Need Help?

Our dedicated technical support team is ready to answer instructors' questions about the media supplements that accompany this text. Visit <http://247.pearsonhighered.com> for answers to frequently asked questions and toll-free user support phone numbers. The supplements are available to adopting instructors. Detailed descriptions are provided at the Instructor's Resource Center.

Instructor's Resource Manual

The Instructor's Resource Manual, updated by Professor Charles Munson of Washington State University, contains many useful resources for instructors—PowerPoint presentations with annotated notes, course outlines, video notes, learning techniques, Internet exercises and sample answers, case analysis ideas, additional teaching resources, and faculty notes. Instructors can download the Instructor's Resource Manual from the Instructor's Resource Center, at www.pearsonhighered.com/heizer.

Instructor's Solutions Manual

The Instructor's Solutions Manual, written by the authors, contains the answers to all of the discussion questions, *Ethical Dilemmas*, Active Models, and cases in the text, as well as worked-out solutions to all the end-of-chapter problems, Internet homework problems, and Internet case studies. Instructors can download the *Instructor's Solutions Manual* from the Instructor's Resource Center, at www.pearsonhighered.com/heizer.

PowerPoint Presentations

An extensive set of PowerPoint presentations, created by Professor Jeff Heyl of Lincoln University, is available for each chapter. With well over 2,000 slides, this set has excellent color and clarity. These slides can also be downloaded from the Instructor's Resource Center, at www.pearsonhighered.com/heizer.

Test Item File

The test item file, updated by Professor Chuck Munson, contains a variety of true/false, multiple-choice, fill-in-the-blank, short-answer, and problem- and topic-integrating questions for each chapter. Test questions are annotated with the following information:

- ▶ Difficulty level
- ▶ Type: multiple-choice, true/false, short-answer, essay
- ▶ Topic: the term or topic the question supports
- ▶ Learning objective
- ▶ AACSB (see the description that follows)

Instructors can download the test item file from the Instructor's Resource Center, at www.pearsonhighered.com/heizer.

The Association to Advance Collegiate Schools of Business (AACSB)

The test item file has connected select questions to the general knowledge and skill guidelines found in the AACSB Assurance of Learning standards.

AACSB is a not-for-profit corporation of educational institutions, corporations, and other organizations devoted to the promotion and improvement of higher education in business administration and accounting. A collegiate institution offering degrees in business administration or accounting may volunteer for AACSB accreditation review. The AACSB makes initial accreditation decisions and conducts periodic reviews to promote continuous quality

AACSB

improvement in management education. Pearson Education is a proud member of the AACSB and is pleased to provide advice to help you apply AACSB assurance of learning standards.

What are AACSB assurance of learning standards? One of the criteria for AACSB accreditation is quality of the curricula. Although no specific courses are required, the AACSB expects a curriculum to include learning experiences in the following areas:

- ▶ Communication
- ▶ Ethical Reasoning
- ▶ Analytic Skills
- ▶ Use of Information Technology
- ▶ Multiculturalism and Diversity
- ▶ Reflective Thinking

Questions that test skills relevant to these guidelines are appropriately tagged. For example, a question regarding clothing manufactured for U.S. firms by 10-year olds in Asia would receive the Ethical Reasoning tag.

Tagged questions help you measure whether students are grasping the course content that aligns with the AACSB guidelines noted. In addition, the tagged questions may help instructors identify potential applications of these skills. This in turn may suggest enrichment activities or other educational experiences to help students achieve these skills.

TestGen

The computerized TestGen package allows instructors to customize, save, and generate classroom tests. The test program permits instructors to edit, add, and delete questions from the test bank; edit existing graphics and create new graphics; analyze test results; and organize a database of test and student results. This software allows for extensive flexibility and ease of use. It provides many options for organizing and displaying tests, along with search and sort features. The software and the test banks can be downloaded from the Instructor's Resource Center, at www.pearsonhighered.com/heizer.

MyOMLab

This powerful tool ties together all elements in this book into a strategic and innovative learning tool, an exam tool, a homework tool, and an assessment center. By using MyOMLab, instructors can assign thousands of problems from the text and/or problems/questions from the test item file for their students to take online at any time, as determined by the instructor. Visit www.myomlab.com for more information.

Video Package

Designed and created by the authors specifically for their Heizer/Render texts, the video package contains the following 36 videos:

- ▶ Frito-Lay: Operations Management in Manufacturing (Chapter 1)
- ▶ Operations Management at Hard Rock (Chapter 1)
- ▶ Regal Marine: Operations Strategy (Chapter 2)
- ▶ Hard Rock Cafe's Global Strategy (Chapter 2)
- ▶ Outsourcing Offshore at Darden (Chapter 2)
- ▶ Project Management at Arnold Palmer Hospital (Chapter 3)
- ▶ Managing Hard Rock's Rockfest (Chapter 3)
- ▶ Forecasting Ticket Revenue for Orlando Magic Basketball Games (Chapter 4)
- ▶ Forecasting at Hard Rock Cafe (Chapter 4)
- ▶ Regal Marine: Product Design (Chapter 5)
- ▶ Building Sustainability at the Orlando Magic's Amway Center (Supplement 5)
- ▶ Green Manufacturing and Sustainability at Frito-Lay (Supplement 5)

- ▶ The Culture of Quality at Arnold Palmer Hospital (Chapter 6)
- ▶ Ritz-Carlton: Quality (Chapter 6)
- ▶ Frito-Lay's Quality-Controlled Potato Chips (Supplement 6)
- ▶ SPC and Quality at Darden Restaurants (Supplement 6)
- ▶ Wheeled Coach: Process Strategy (Chapter 7)
- ▶ Process Analysis at Arnold Palmer Hospital (Chapter 7)
- ▶ Capacity Planning at Arnold Palmer Hospital (Supplement 7)
- ▶ Locating the Next Red Lobster (Chapter 8)
- ▶ Where to Place the Hard Rock Cafe (Chapter 8)
- ▶ Wheeled Coach: Facility Layout (Chapter 9)
- ▶ Laying Out Arnold Palmer Hospital's New Facility (Chapter 9)
- ▶ Hard Rock Cafe's Human Resource Strategy (Chapter 10)
- ▶ Darden's Global Supply Chains (Chapter 11)
- ▶ Regal Marine: Supply Chain Management (Chapter 11)
- ▶ Arnold Palmer Hospital's Supply Chain (Chapter 11)
- ▶ Managing Inventory at Frito-Lay (Chapter 12)
- ▶ Wheeled Coach: Inventory Control (Chapter 12)
- ▶ Using Revenue Management to Set Orlando Magic Ticket Prices (Chapter 13)
- ▶ When 18,000 Orlando Magic Fans Come to Dinner (Chapter 14)
- ▶ Wheeled Coach: Materials Requirements Planning (Chapter 14)
- ▶ From the Eagles to the Magic: Converting the Amway Center (Chapter 15)
- ▶ Scheduling at Hard Rock Cafe (Chapter 15)
- ▶ JIT at Arnold Palmer Hospital (Chapter 16)
- ▶ Maintenance Drives Profits at Frito-Lay (Chapter 17)

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Moshen Attaran
California State University–Bakersfield

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California State University–Northridge

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California State University–Hayward

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San Diego State University

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San Francisco State University

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Peter Billington
Colorado State University–Pueblo

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David Cadden
Quinnipiac University

Larry A. Flick
Norwalk Community Technical College

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Joseph P. Geunes
University of Florida

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Jim Gilbert
Rollins College

Donald Hammond
University of South Florida

Adam Munson

University of Florida

Ronald K. Satterfield

University of South Florida

Theresa A. Shotwell

Florida A&M University

GEORGIA

John H. Blackstone

University of Georgia

Johnny Ho

Columbus State University

John Hoft

Columbus State University

John Miller

Mercer University

Spyros Reveliotis

Georgia Institute of Technology

ILLINOIS

Suad Alwan

Chicago State University

Lori Cook

DePaul University

Matt Liontine

University of Illinois–Chicago

Zafar Malik

Governors State University

INDIANA

Barbara Flynn

Indiana University

B.P. Lingeraj

Indiana University

Frank Pianki

Anderson University

Stan Stockton

Indiana University

Jianghua Wu

Purdue University

Xin Zhai

Purdue University

IOWA

Kevin Watson

Iowa State University

Lifang Wu

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Emporia State University

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Wichita State University

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Washburn University

M.J. Riley

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Wichita State University

KENTUCKY

Wade Ferguson

Western Kentucky University

Kambiz Tabibzadeh

Eastern Kentucky University

LOUISIANA

Roy Clinton

University of Louisiana at Monroe

L. Wayne Shell (retired)

Nicholls State University

MARYLAND

Eugene Hahn

Salisbury University

Samuel Y. Smith, Jr.

University of Baltimore

MASSACHUSETTS

Peter Ittig

University of Massachusetts

Jean Pierre Kuilboer

University of Massachusetts–Boston

Dave Lewis

University of Massachusetts–Lowell

Mike Maggard (retired)

Northeastern University

Peter Rourke

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Daniel Shimshak

University of Massachusetts–Boston

Ernest Silver

Curry College

MICHIGAN

Darlene Burk

Western Michigan University

Damodar Golhar

Western Michigan University

Dana Johnson

Michigan Technological University

Doug Moodie

Michigan Technological University

MINNESOTA

Rick Carlson

Metropolitan State University

John Nicolay

University of Minnesota

Michael Pesch

St. Cloud State University

Manus Rungtusanatham

University of Minnesota

Kingshuk Sinha

University of Minnesota

MISSOURI

Shahid Ali

Rockhurst University

Stephen Allen

Truman State University

Sema Alptekin

University of Missouri–Rolla

Gregory L. Bier

University of Missouri–Columbia

James Campbell

University of Missouri–St. Louis

Wooseung Jang

University of Missouri–Columbia

Mary Marrs

University of Missouri–Columbia

A. Lawrence Summers

University of Missouri

NEBRASKA

Zialu Hug

University of Nebraska–Omaha

NEVADA

Joel D. Wisner

University of Nevada, Las Vegas

NEW JERSEY

Daniel Ball

Monmouth University

Leon Bazil

Stevens Institute of Technology

Mark Berenson

Montclair State University

Grace Greenberg

Rider University

Joao Neves

The College of New Jersey

Leonard Presby

William Paterson University

Faye Zhu

Rowan University

NEW MEXICO

William Kime

University of New Mexico

NEW YORK

Theodore Boreki

Hofstra University

John Drabouski
DeVry University

Richard E. Dulski
Daemen College

Jonatan Jelen
Baruch College

Beate Klingenberg
Marist College

Donna Mosier
SUNY Potsdam

Elizabeth Perry
SUNY Binghamton

William Reisel
St. John's University

Kaushik Sengupta
Hofstra University

Girish Shambu
Canisius College

Rajendra Tibrewala
New York Institute of Technology

NORTH CAROLINA

Ray Walters
*Fayetteville Technical
Community College*

OHIO

Victor Berardi
Kent State University

Andrew R. Thomas
University of Akron

OKLAHOMA

Wen-Chyuan Chiang
University of Tulsa

OREGON

Anne Deidrich
Warner Pacific College

Gordon Miller
Portland State University

John Sloan
Oregon State University

PENNSYLVANIA

Henry Crouch
Pittsburgh State University

Jeffrey D. Heim
Pennsylvania State University

Ian M. Langella
Shippensburg University

Prafulla Oglekar
LaSalle University

David Pentico
Duquesne University

Stanford Rosenberg
LaRoche College

Edward Rosenthal
Temple University

Susan Sherer
Lehigh University

Howard Weiss
Temple University

RHODE ISLAND

Laurie E. Macdonald
Bryant College

John Swearingen
Bryant College

Susan Sweeney
Providence College

SOUTH CAROLINA

Jerry K. Bilbrey
Anderson University

Larry LaForge
Clemson University

Emma Jane Riddle
Winthrop University

TENNESSEE

Joseph Blackburn
Vanderbilt University

Hugh Daniel
Lipscomb University

Cliff Welborn
Middle Tennessee State University

TEXAS

Warren W. Fisher
Stephen F. Austin State University

Garland Hunnicutt
Texas State University

Gregg Lattier
Lee College

Henry S. Maddux III
Sam Houston State University

Arunachalam Narayanan
Texas A&M University

Ranga V. Ramasesh
Texas Christian University

Victor Sower
San Houston State University

Cecelia Temponi
Texas State University

John Visich-Disc
University of Houston

Dwayne Whitten
Texas A&M University

Bruce M. Woodworth
University of Texas–El Paso

UTAH

William Christensen
Dixie State College of Utah

Shane J. Schvaneveldt
Weber State University

Madeline Thimmes (retired)
Utah State University

VIRGINIA

Andy Litteral
University of Richmond

Arthur C. Meiners, Jr.
Marymount University

Michael Plumb
Tidewater Community College

WASHINGTON

Mark McKay
University of Washington

Chuck Munson
Washington State University

Chris Sandvig
Western Washington University

John Stec
Oregon Institute of Technology

WASHINGTON, DC

Narendra K. Rustagi
Howard University

WEST VIRGINIA

Charles Englehardt
Salem International University

Daesung Ha
Marshall University

John Harpell
West Virginia University

James S. Hawkes
University of Charleston

WISCONSIN

James R. Gross
University of Wisconsin–Oshkosh

Marilyn K. Hart (retired)
University of Wisconsin–Oshkosh

Niranjan Pati
University of Wisconsin–La Crosse

X. M. Safford
Milwaukee Area Technical College

Rao J. Taikonda
University of Wisconsin–Oshkosh

WYOMING

Cliff Asay
University of Wyoming

INTERNATIONAL

Robert D. Klassen
University of Western Ontario

Ronald Lau
*Hong Kong University of Science and
Technology*

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We wish you a pleasant and productive introduction to operations management.

BARRY RENDER

Graduate School of Business
Rollins College
Winter Park, FL 32789
Email: brender@rollins.edu

JAY HEIZER

Texas Lutheran University
1000 W. Court Street
Seguin, TX 78155
Email: jheizer@tlu.edu

TWO VERSIONS ARE AVAILABLE

This text is available in two versions: *Operations Management*, 11th edition, a hardcover, and *Principles of Operations Management*, 9th edition, a paperback. Both books include the identical core Chapters 1–17. However, *Operations Management*, 11th edition also includes six business analytics modules in Part IV.

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3. Project Management
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6. Managing Quality
- S6. Statistical Process Control
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OPERATIONS MANAGEMENT

Sustainability and Supply Chain Management

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Operations and Productivity

1

CHAPTER

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- Design of Goods and Services
- Managing Quality
- Process Strategy
- Location Strategies
- Layout Strategies
- Human Resources
- Supply-Chain Management
- Inventory Management
- Scheduling
- Maintenance

GLOBAL COMPANY PROFILE
Hard Rock Cafe

Operations Management at Hard Rock Cafe

Operations managers throughout the world are producing products every day to provide for the well-being of society. These products take on a multitude of forms. They may be washing machines at Whirlpool, motion pictures at DreamWorks, rides at Disney World, or food at Hard Rock Cafe. These firms produce thousands of complex products every day—to be delivered as the customer ordered them, when the customer wants them, and where the customer wants them. Hard Rock does this for over 35 million guests worldwide every year. This is a challenging task, and the operations manager's job, whether at Whirlpool, DreamWorks, Disney, or Hard Rock, is demanding.



Andre Jenny/Alamy

Hard Rock Cafe in Orlando, Florida, prepares over 3,500 meals each day. Seating more than 1,500 people, it is one of the largest restaurants in the world. But Hard Rock's operations managers serve the hot food hot and the cold food cold.

Operations managers are interested in the attractiveness of the layout, but they must be sure that the facility contributes to the efficient movement of people and material with the necessary controls to ensure that proper portions are served.



Demetrio Carrasco © Rough Guides



Lots of work goes into designing, testing, and costing meals. Then suppliers deliver quality products on time, every time, for well-trained cooks to prepare quality meals. But none of that matters unless an enthusiastic wait staff, such as the one shown here, holding guitars previously owned by members of US, is doing its job.

Orlando-based Hard Rock Cafe opened its first restaurant in London in 1971, making it over 42 years old and the granddaddy of theme restaurants. Although other theme restaurants have come and gone, Hard Rock is still going strong, with 150 restaurants in more than 53 countries—and new restaurants opening each year. Hard Rock made its name with rock music memorabilia, having started when Eric Clapton, a regular customer, marked his favorite bar stool by hanging his guitar on the wall in the London cafe. Now Hard Rock has 70,000 items and millions of dollars invested in memorabilia. To keep customers coming back time and again, Hard Rock creates value in the form of good food and entertainment.

The operations managers at Hard Rock Cafe at Universal Studios in Orlando provide more than 3,500 custom products—in this case meals—every day. These products are designed, tested, and then analyzed for cost of ingredients,



Efficient kitchen layouts, motivated personnel, tight schedules, and the right ingredients at the right place at the right time are required to delight the customer.

labor requirements, and customer satisfaction. On approval, menu items are put into production—and then only if the ingredients are available from qualified suppliers. The production process, from receiving, to cold storage, to grilling or baking or frying, and a dozen other steps, is designed and maintained to yield a quality meal. Operations managers, using the best people they can recruit and train, also prepare effective employee schedules and design efficient layouts.

Managers who successfully design and deliver goods and services throughout the world understand operations. In this text, we look not only at how Hard Rock's managers create value but also how operations managers in other services, as well as in manufacturing, do so. Operations management is demanding, challenging, and exciting. It affects our lives every day. Ultimately, operations managers determine how well we live. **K**

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LO4	Compute single-factor productivity	14
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STUDENT TIP ☆

Let's begin by defining what this course is about.

What Is Operations Management?

LO1 Define operations management

VIDEO 1.1

Operations Management at Hard Rock

VIDEO 1.2

Operations Management at Frito-Lay

Operations management (OM) is a discipline that applies to restaurants like Hard Rock Cafe as well as to factories like Ford and Whirlpool. The techniques of OM apply throughout the world to virtually all productive enterprises. It doesn't matter if the application is in an office, a hospital, a restaurant, a department store, or a factory—the production of goods and services requires operations management. And the *efficient* production of goods and services requires effective applications of the concepts, tools, and techniques of OM that we introduce in this book.

As we progress through this text, we will discover how to manage operations in an economy in which both customers and suppliers are located throughout the world. An array of informative examples, charts, text discussions, and pictures illustrates concepts and provides information. We will see how operations managers create the goods and services that enrich our lives.

In this chapter, we first define *operations management*, explaining its heritage and exploring the exciting role operations managers play in a huge variety of organizations. Then we discuss production and productivity in both goods- and service-producing firms. This is followed by a discussion of operations in the service sector and the challenge of managing an effective and efficient production system.

Production

The creation of goods and services.

Operations management (OM)

Activities that relate to the creation of goods and services through the transformation of inputs to outputs.

Production is the creation of goods and services. **Operations management (OM)** is the set of activities that creates value in the form of goods and services by transforming inputs into outputs. Activities creating goods and services take place in all organizations. In manufacturing firms, the production activities that create goods are usually quite obvious. In them, we can see the creation of a tangible product such as a Sony TV or a Harley-Davidson motorcycle.

In an organization that does not create a tangible good or product, the production function may be less obvious. We often call these activities *services*. The services may be “hidden” from the public and even from the customer. The product may take such forms as the transfer of funds from a savings account to a checking account, the transplant of a liver, the filling of an empty seat on an airplane, or the education of a student. Regardless of whether the end product is a good or service, the production activities that go on in the organization are often referred to as operations, or *operations management*.

STUDENT TIP ☆

Operations is one of the three functions that every organization performs.

Organizing to Produce Goods and Services

To create goods and services, all organizations perform three functions (see Figure 1.1). These functions are the necessary ingredients not only for production but also for an organization's survival. They are:

1. *Marketing*, which generates the demand, or at least takes the order for a product or service (nothing happens until there is a sale).
2. *Production/operations*, which creates the product.
3. *Finance/accounting*, which tracks how well the organization is doing, pays the bills, and collects the money.

Universities, churches or synagogues, and businesses all perform these functions. Even a volunteer group such as the Boy Scouts of America is organized to perform these three basic

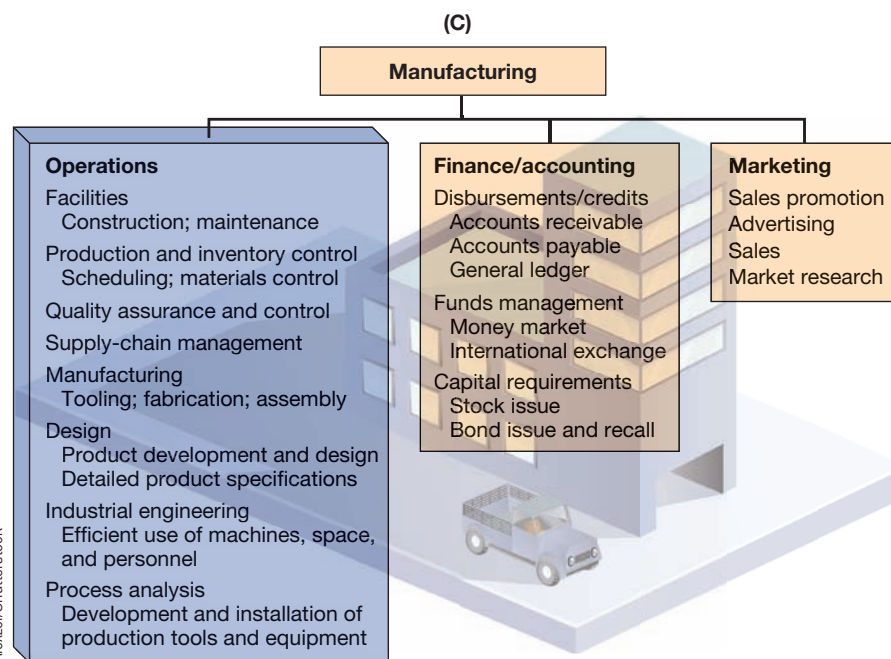
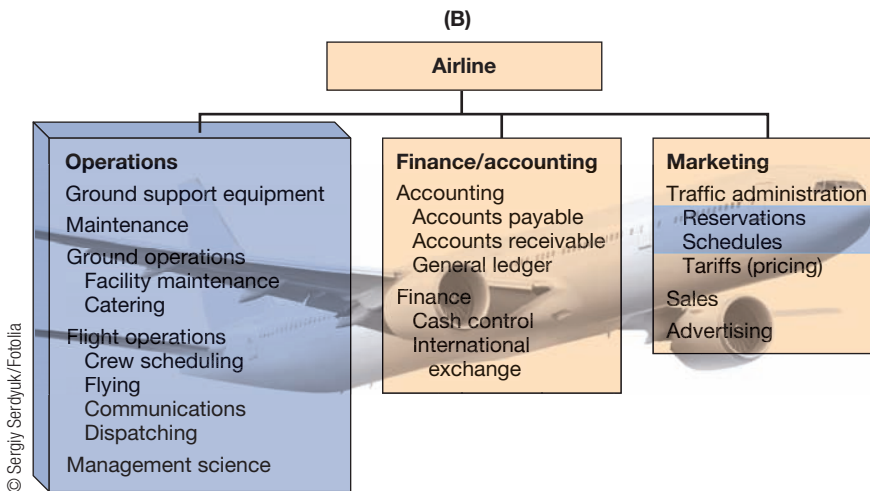
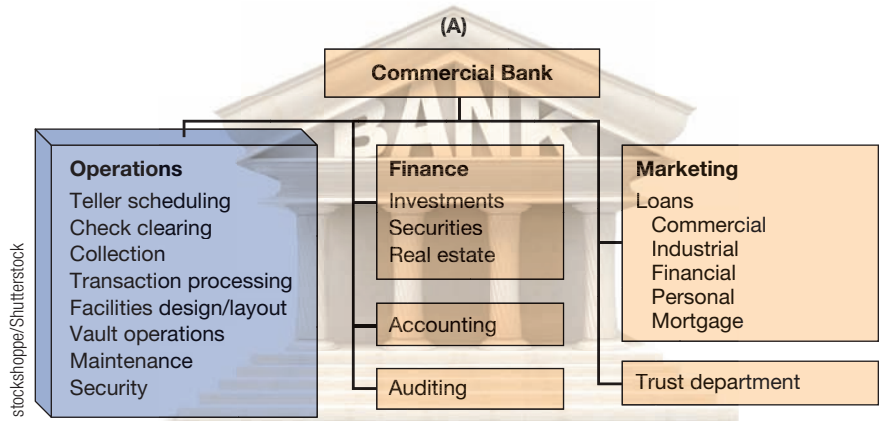


Figure 1.1
Organization Charts for Two Service Organizations and One Manufacturing Organization

(A) a bank, (B) an airline, and (C) a manufacturing organization. The blue areas are OM activities.

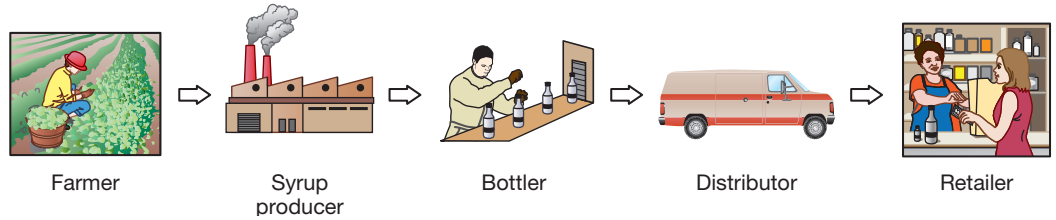
★ **STUDENT TIP**

The areas in blue indicate the significant role that OM plays in both manufacturing and service firms.

Figure 1.2

Soft Drink Supply Chain

A supply chain for a bottle of Coke requires a beet or sugar cane farmer, a syrup producer, a bottler, a distributor, and a retailer, each adding value to satisfy a customer. Only with collaborations between all members of the supply chain can efficiency and customer satisfaction be maximized. The supply chain, in general, starts with the provider of basic raw materials and continues all the way to the final customer at the retail store.



functions. Figure 1.1 shows how a bank, an airline, and a manufacturing firm organize themselves to perform these functions. The blue-shaded areas show the operations functions in these firms.

The Supply Chain

Through the three functions—marketing, operations, and finance—value for the customer is created. However, firms seldom create this value by themselves. Instead, they rely on a variety of suppliers who provide everything from raw materials to accounting services. These suppliers, when taken together, can be thought of as a *supply chain*. A **supply chain** (see Figure 1.2) is a global network of organizations and activities that supply a firm with goods and services.

As our society becomes more technologically oriented, we see increasing specialization. Specialized expert knowledge, instant communication, and cheaper transportation also foster specialization and worldwide supply chains. It just does not pay for a firm to try to do everything itself. The expertise that comes with specialization exists up and down the supply chain, adding value at each step. When members of the supply chain collaborate to achieve high levels of customer satisfaction, we have a tremendous force for efficiency and competitive advantage. Competition in the 21st century is no longer between companies; it is between *supply chains*.

Supply chain

A global network of organizations and activities that supplies a firm with goods and services.

STUDENT TIP ☆

Good OM managers are scarce and, as a result, career opportunities and pay are excellent.

Why Study OM?

We study OM for four reasons:

1. OM is one of the three major functions of any organization, and it is integrally related to all the other business functions. All organizations market (sell), finance (account), and produce (operate), and it is important to know how the OM activity functions. Therefore, we study *how people organize themselves for productive enterprise*.
2. We study OM because we want to know *how goods and services are produced*. The production function is the segment of our society that creates the products and services we use.
3. We study OM to *understand what operations managers do*. Regardless of your job in an organization, you can perform better if you understand what operations managers do. In addition, understanding OM will help you explore the numerous and lucrative career opportunities in the field.
4. We study OM *because it is such a costly part of an organization*. A large percentage of the revenue of most firms is spent in the OM function. Indeed, OM provides a major opportunity for an organization to improve its profitability and enhance its service to society. Example 1 considers how a firm might increase its profitability via the production function.

Example 1

EXAMINING THE OPTIONS FOR INCREASING CONTRIBUTION

Fisher Technologies is a small firm that must double its dollar contribution to fixed cost and profit in order to be profitable enough to purchase the next generation of production equipment. Management has determined that if the firm fails to increase contribution, its bank will not make the loan and the equipment cannot be purchased. If the firm cannot purchase the equipment, the limitations of the old equipment will force Fisher to go out of business and, in doing so, put its employees out of work and discontinue producing goods and services for its customers.

APPROACH ► Table 1.1 shows a simple profit-and-loss statement and three strategic options (marketing, finance/accounting, and operations) for the firm. The first option is a *marketing option*, where excellent marketing management may increase sales by 50%. By increasing sales by 50%, contribution will in turn increase 71%. But increasing sales 50% may be difficult; it may even be impossible.

TABLE 1.1 Options for Increasing Contribution

	CURRENT	MARKETING OPTION ^a INCREASE SALES REVENUE 50%	FINANCE/ACCOUNTING OPTION ^b REDUCE FINANCE COSTS 50%	OM OPTION ^c REDUCE PRODUCTION COSTS 20%
Sales	\$100,000	\$150,000	\$100,000	\$100,000
Costs of goods	<u>-80,000</u>	<u>-120,000</u>	<u>-80,000</u>	<u>-64,000</u>
Gross margin	20,000	30,000	20,000	36,000
Finance costs	<u>-6,000</u>	<u>-6,000</u>	<u>-3,000</u>	<u>-6,000</u>
Subtotal	14,000	24,000	17,000	30,000
Taxes at 25%	<u>-3,500</u>	<u>-6,000</u>	<u>-4,250</u>	<u>-7,500</u>
Contribution ^d	\$ 10,500	\$ 18,000	\$ 12,750	\$ 22,500

^aIncreasing sales 50% increases contribution by \$7,500, or 71% (7,500/10,500).
^bReducing finance costs 50% increases contribution by \$2,250, or 21% (2,250/10,500).
^cReducing production costs 20% increases contribution by \$12,000, or 114% (12,000/10,500).
^dContribution to fixed cost (excluding finance costs) and profit.

The second option is a *finance/accounting option*, where finance costs are cut in half through good financial management. But even a reduction of 50% is still inadequate for generating the necessary increase in contribution. Contribution is increased by only 21%.

The third option is an *OM option*, where management reduces production costs by 20% and increases contribution by 114%.

SOLUTION ► Given the conditions of our brief example, Fisher Technologies has increased contribution from \$10,500 to \$22,500. It may now have a bank willing to lend it additional funds.

INSIGHT ► The OM option not only yields the greatest improvement in contribution but also may be the only feasible option. Increasing sales by 50% and decreasing finance cost by 50% may both be virtually impossible. Reducing operations cost by 20% may be difficult but feasible.

LEARNING EXERCISE ► What is the impact of only a 15% decrease in costs in the OM option? [Answer: A \$19,500 contribution; an 86% increase.]

Example 1 underscores the importance of the effective operations activity of a firm. Development of increasingly effective operations is the approach taken by many companies as they face growing global competition.

What Operations Managers Do

All good managers perform the basic functions of the management process. The management process consists of *planning, organizing, staffing, leading, and controlling*. Operations managers apply this management process to the decisions they make in the OM function. The **10 strategic OM decisions** are introduced in Table 1.2. Successfully addressing each of these decisions requires planning, organizing, staffing, leading, and controlling.

Where Are the OM Jobs? How does one get started on a career in operations? The 10 strategic OM decisions identified in Table 1.2 are made by individuals who work in the disciplines shown in the blue areas of Figure 1.1. Business students who know their accounting,

10 Strategic OM Decisions

- Design of goods and services
- Managing quality
- Process strategy
- Location strategies
- Layout strategies
- Human resources
- Supply-chain management
- Inventory management
- Scheduling
- Maintenance

STUDENT TIP ☆

An operations manager must successfully address the 10 decisions around which this text is organized.

TABLE 1.2 Ten Strategic Operations Management Decisions

DECISION	CHAPTER(S)
1. <i>Design of goods and services</i> : Defines much of what is required of operations in each of the other OM decisions. For instance, product design usually determines the lower limits of cost and the upper limits of quality, as well as major implications for sustainability and the human resources required.	5, Supplement 5
2. <i>Managing quality</i> : Determines the customer's quality expectations and establishes policies and procedures to identify and achieve that quality.	6, Supplement 6
3. <i>Process and capacity design</i> : Determines how a good or service is produced (i.e., the process for production) and commits management to specific technology, quality, human resources, and capital investments that determine much of the firm's basic cost structure.	7, Supplement 7
4. <i>Location strategy</i> : Requires judgments regarding nearness to customers, suppliers, and talent, while considering costs, infrastructure, logistics, and government.	8
5. <i>Layout strategy</i> : Requires integrating capacity needs, personnel levels, technology, and inventory requirements to determine the efficient flow of materials, people, and information.	9
6. <i>Human resources and job design</i> : Determines how to recruit, motivate, and retain personnel with the required talent and skills. People are an integral and expensive part of the total system design.	10
7. <i>Supply-chain management</i> : Decides how to integrate the supply chain into the firm's strategy, including decisions that determine what is to be purchased, from whom, and under what conditions.	11, Supplement 11
8. <i>Inventory management</i> : Considers inventory ordering and holding decisions and how to optimize them as customer satisfaction, supplier capability, and production schedules are considered.	12, 14, 16
9. <i>Scheduling</i> : Determines and implements intermediate- and short-term schedules that effectively and efficiently utilize both personnel and facilities while meeting customer demands.	13, 15
10. <i>Maintenance</i> : Requires decisions that consider facility capacity, production demands, and personnel necessary to maintain a reliable and stable process.	17

statistics, finance, and OM have an opportunity to assume entry-level positions in all of these areas. As you read this text, identify disciplines that can assist you in making these decisions. Then take courses in those areas. The more background an OM student has in accounting, statistics, information systems, and mathematics, the more job opportunities will be available. About 40% of *all* jobs are in OM.

The following professional organizations provide various certifications that may enhance your education and be of help in your career:

- ▶ APICS, the Association for Operations Management (www.apics.org)
- ▶ American Society for Quality (ASQ) (www.asq.org)
- ▶ Institute for Supply Management (ISM) (www.ism.ws)
- ▶ Project Management Institute (PMI) (www.pmi.org)
- ▶ Council of Supply Chain Management Professionals (www.cscmp.org)

Figure 1.3 shows some recent job opportunities.

The Heritage of Operations Management

The field of OM is relatively young, but its history is rich and interesting. Our lives and the OM discipline have been enhanced by the innovations and contributions of numerous individuals. We now introduce a few of these people, and we provide a summary of significant events in operations management in Figure 1.4.

Operations Management Positions	
SEARCH JOBS	
Date	Job Title
1/15	<p><u>Plant Manager</u></p> <p>Division of Fortune 1000 company seeks plant manager for plant located in the upper Hudson Valley area. This plant manufactures loading dock equipment for commercial markets. The candidate must be experienced in plant management including expertise in production planning, purchasing, and inventory management. Good written and oral communication skills are a must, along with excellent application of skills in managing people.</p>
2/23	<p><u>Operations Analyst</u></p> <p>Expanding national coffee shop: top 10 “Best Places to Work” wants junior level systems analyst to join our excellent store improvement team. Business or I.E. degree, work methods, labor standards, ergonomics, cost accounting knowledge a plus. This is a hands-on job and excellent opportunity for a team player with good people skills. West Coast location. Some travel required.</p>
3/18	<p><u>Quality Manager</u></p> <p>Several openings exist in our small package processing facilities in the Northeast, Florida, and Southern California for quality managers. These highly visible positions require extensive use of statistical tools to monitor all aspects of service, timeliness, and workload measurement. The work involves (1) a combination of hands-on applications and detailed analysis using databases and spreadsheets, (2) processing of audits to identify areas for improvement and (3) management of implementation of changes. Positions involve night hours and weekends.</p>
4/6	<p><u>Supply-Chain Manager and Planner</u></p> <p>Responsibilities entail negotiating contracts and establishing long-term relationships with suppliers. We will rely on the selected candidate to maintain accuracy in the purchasing system, invoices, and product returns. A bachelor's degree and up to 2 years related experience are required. Working knowledge of MRP, ability to use feedback to master scheduling and suppliers and consolidate orders for best price and delivery are necessary. Proficiency in all PC Windows applications, particularly Excel and Word, is essential. Effective verbal and written communication skills are essential.</p>
5/14	<p><u>Process Improvement Consultants</u></p> <p>An expanding consulting firm is seeking consultants to design and implement lean production and cycle time reduction plans in both service and manufacturing processes. Our firm is currently working with an international bank to improve its back office operations, as well as with several manufacturing firms. A business degree required; APICS certification a plus.</p>

Figure 1.3

Many Opportunities Exist for Operations Managers

Eli Whitney (1800) is credited for the early popularization of interchangeable parts, which was achieved through standardization and quality control. Through a contract he signed with the U.S. government for 10,000 muskets, he was able to command a premium price because of their interchangeable parts.

Frederick W. Taylor (1881), known as the father of scientific management, contributed to personnel selection, planning and scheduling, motion study, and the now popular field of ergonomics. One of his major contributions was his belief that management should be much more resourceful and aggressive in the improvement of work methods. Taylor and his colleagues, Henry L. Gantt and Frank and Lillian Gilbreth, were among the first to systematically seek the best way to produce.

Another of Taylor's contributions was the belief that management should assume more responsibility for:

1. Matching employees to the right job.
2. Providing the proper training.
3. Providing proper work methods and tools.
4. Establishing legitimate incentives for work to be accomplished.