

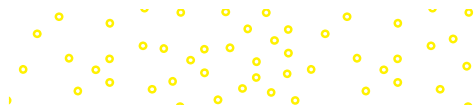
FIFTH EDITION

OPERATIONS AND SUPPLY CHAIN MANAGEMENT

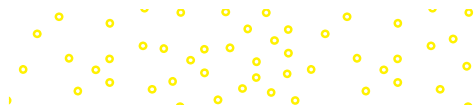
THE CORE

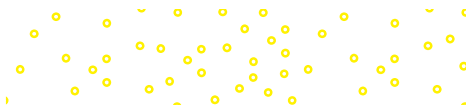
**Mc
Graw
Hill**
Education

**F. ROBERT JACOBS
RICHARD B. CHASE**



Operations and Supply Chain Management: The Core





The McGraw-Hill/Irwin Series in Operations and Decision Sciences

SUPPLY CHAIN MANAGEMENT

Benton

Purchasing and Supply Chain Management
Third Edition

Bowersox, Closs, Cooper, and Bowersox

Supply Chain Logistics Management
Fifth Edition

Burt, Petcavage, and Pinkerton

Supply Management
Eighth Edition

Johnson

Purchasing and Supply Management
Sixteenth Edition

Simchi-Levi, Kaminsky, and Simchi-Levi

Designing and Managing the Supply Chain:
Concepts, Strategies, Case Studies
Third Edition

Stock and Manrodt

Fundamentals of Supply Chain Management

PROJECT MANAGEMENT

Brown and Hyer

Managing Projects: A Team-Based
Approach

Larson and Gray

Project Management: The Managerial
Process
Seventh Edition

SERVICE OPERATIONS MANAGEMENT

Bordoloi, Fitzsimmons, and Fitzsimmons

Service Management: Operations, Strategy,
Information Technology
Ninth Edition

MANAGEMENT SCIENCE

Hillier and Hillier

Introduction to Management Science: A
Modeling and Case Studies Approach with
Spreadsheets
Sixth Edition

BUSINESS RESEARCH METHODS

Schindler

Business Research Methods
Thirteenth Edition

BUSINESS FORECASTING

Keating and Wilson

Forecasting and Predictive Analytics
Seventh Edition

LINEAR STATISTICS AND REGRESSION

Kutner, Nachtsheim, and Neter

Applied Linear Regression Models
Fourth Edition

BUSINESS SYSTEMS DYNAMICS

Sterman

Business Dynamics: Systems Thinking and
Modeling for a Complex World

OPERATIONS MANAGEMENT

Cachon and Terwiesch

Operations Management
Second Edition

Cachon and Terwiesch

Matching Supply with Demand: An
Introduction to Operations Management
Fourth Edition

Jacobs and Chase

Operations and Supply Chain Management
Fifteenth Edition

Jacobs and Chase

Operations and Supply Chain Management:
The Core
Fifth Edition

Jacobs, Berry, Whybark, and Vollmann

Manufacturing Planning & Control for
Supply Chain Management
Second Edition

Schroeder and Goldstein

Operations Management in the Supply
Chain: Decisions and Cases
Seventh Edition

Stevenson

Operations Management
Thirteenth Edition

Swink, Melnyk, and Hartley

Managing Operations Across the Supply
Chain
Fourth Edition

BUSINESS MATH

Slater and Wittry

Practical Business Math Procedures
Thirteenth Edition

Slater and Wittry

Math for Business and Finance: An
Algebraic Approach
Second Edition

BUSINESS STATISTICS

Bowerman, O'Connell, Drougas,**Duckworth, and Froelich**

Business Statistics in Practice
Ninth Edition

Doane and Seward

Applied Statistics in Business and
Economics
Sixth Edition

Doane and Seward

Essential Statistics in Business and
Economics
Third Edition

Lind, Marchal, and Wathen

Basic Statistics for Business and Economics
Ninth Edition

Lind, Marchal, and Wathen

Statistical Techniques in Business and
Economics
Seventeenth Edition

Jaggia and Kelly

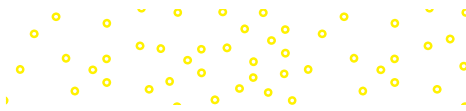
Business Statistics: Communicating with
Numbers
Third Edition

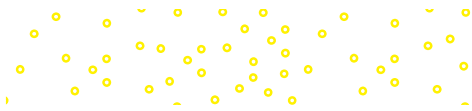
Jaggia and Kelly

Essentials of Business Statistics:
Communicating with Numbers
Second Edition

McGuckian

Connect Master: Business Statistics





Operations and Supply Chain Management: The Core

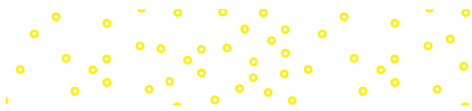
Fifth Edition

F. ROBERT JACOBS

Indiana University

RICHARD B. CHASE

University of Southern California





OPERATIONS AND SUPPLY CHAIN MANAGEMENT: THE CORE, FIFTH EDITION

Published by McGraw-Hill Education, 2 Penn Plaza, New York, NY 10121. Copyright © 2020 by McGraw-Hill Education. All rights reserved. Printed in the United States of America. Previous editions © 2017, 2013, and 2010. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of McGraw-Hill Education, including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 LWI 21 20 19

ISBN 978-1-260-23888-4

MHID 1-260-23888-1

Portfolio Manager: *Noelle Bathurst*

Product Developer: *Ryan McAndrews*

Marketing Manager: *Harper Christopher*

Content Project Managers: *Fran Simon/Jamie Koch*

Buyer: *Sandy Ludovissy*

Design: *Egzon Shaqiri*

Content Licensing Specialists: *Shawntel Schmitt*

Cover Image: ©*jimwiltshcko/gettyimages*

Compositor: *SPi Global*

All credits appearing on page or at the end of the book are considered to be an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

Names: Jacobs, F. Robert, author. | Chase, Richard B., author.

Title: Operations and supply chain management. The core / F. Robert Jacobs,

Indiana University, Richard B. Chase, University of Southern California.

Description: Fifth edition. | New York, NY : McGraw-Hill Education, [2020]

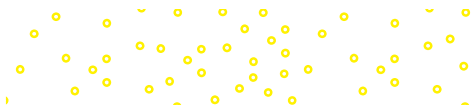
Identifiers: LCCN 2018044375 | ISBN 9781260238884 (alk. paper)

Subjects: LCSH: Production management.

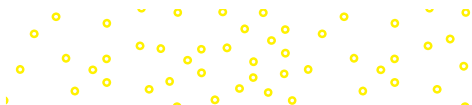
Classification: LCC TS155 .J273 2017 | DDC 658.5—dc23

LC record available at <https://lccn.loc.gov/2018044375>

The Internet addresses listed in the text were accurate at the time of publication. The inclusion of a website does not indicate an endorsement by the authors or McGraw-Hill Education, and McGraw-Hill Education does not guarantee the accuracy of the information presented at these sites.



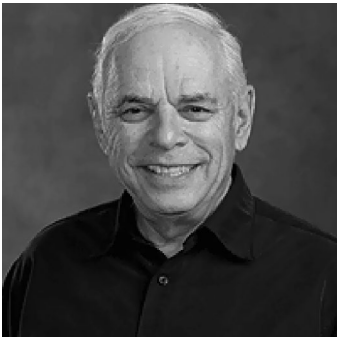
*To Cole, Connor,
and Grant—the next
generation.*



ABOUT THE AUTHORS



F. Robert Jacobs is Professor Emeritus of Operations and Decision Technologies at Indiana University. He received a BS in industrial engineering as well as computer and information science, an MBA, and a PhD in operations management all from The Ohio State University. He has also taught at the University of Houston and The Ohio State University. He has published 7 books and over 50 research articles on topics that include enterprise resource planning, inventory control, the design of manufacturing facilities, cellular manufacturing, and the scheduling of manufacturing operations. He is a Fellow of the Decision Sciences Institute and past president and has received teaching honors such as MBA Teaching Award, Students Award for Teaching Excellence in International Business Issues, and Teaching Excellence in Operations Management.



Richard B. Chase is Justin B. Dart Professor Emeritus of Operations Management at the Marshall School of Business, University of Southern California. He received his PhD in operations management, as well as an MBA and BS from UCLA. He has taught at the Harvard Business School, IMD (Switzerland), and the University of Arizona. His research examines service process design and service strategy. In 2006 he received a POMS Lifetime Achievement Award for his research in service operations and in 2004 received a Scholar of the Year Award by the Academy of Management. In 2009, he was honored in the *Production & Operations Management Journal* for his contributions to operations management. He is a Fellow of the Academy of Management, Production Operations Management Society, and the Decision Sciences Institute. He was also an examiner for the Malcolm Baldrige National Quality Award. Dr. Chase has lectured/consulted recently on service and excellence to such organizations as Cisco Systems, Four Seasons Resorts, General Electric, and the Gartner Group.

PREFACE

Just as lava flows from the core of the earth, operations and supply management is the core of business. Materials must flow through supply processes to create cash output and profits.

In Operations and Supply Management: The Core 2e, we take students to the center of the business and focus on the core concepts and tools needed to ensure that these processes run smoothly.

The goal of this book is to provide you with the essential information that every manager needs to know about operations and supply chain–related activities in a firm. Things have changed dramatically over the last few years. Organization structures are now much flatter, and rather than being functionally organized, companies often are organized by customer and product groups. Today’s manager cannot ignore how the real work of the organization is done. This book is all about how to get the real work done effectively. It makes little difference if you are officially in finance, marketing, accounting, or operations: The value-added work, the process of creating and delivering products, needs to be completed in a manner that is both high quality and maximally efficient. Many of the things you do, or will do, in your job are repetitive, even some of the most creative and high-profile activities. You should think of this course as preparing you to be your most productive and helping you help your organization be its most productive.

We can consider the importance of the material in this book on many levels, but let’s focus on three. First, consider your role as a business unit manager with people working under your supervision. Next, in the longer term, you probably have aspirations to become a senior executive with responsibility for multiple businesses or products. Finally, you may decide to specialize in operations and supply chain management as a long-term career.

In your role as a manager with people working under your supervision, one of your major duties will be to organize the way work is done. There needs to be some structure to the work process, including how information is captured and analyzed, as well as how decisions and changes and improvements are made. Without a logical or structured approach, even a small group may be subject to errors, inefficiencies, and even chaos.

Designing efficient process flows is an important element of getting a group to work together. If your group is involved in creative activities such as designing cars, buildings, or even stock portfolios, there still needs to be structure to how the work is done, who is responsible for what, and how progress is reported. The concepts of project management, manufacturing and service process design, capacity analysis, and quality in this text are all directly related to the knowledge you will need to be a great supervisor in your organization, and getting your group to work productively and efficiently will lead to success and more responsibility for you.

Next, think about becoming a senior executive. Making acquisitions, planning mergers, and buying and selling divisions will get your name and picture in business magazines. Deals are easily explained to boards, shareholders, and the media. They are newsworthy and offer the prospect of nearly immediate gratification, and being a deal maker is consistent with the image of the modern executive as someone who focuses on grand strategy and leaves operations details to others. Unfortunately, the majority of deals are unsuccessful. The critical element of success, even with the grandest deals, can still be found most often in the operational details.

Real success happens when operational processes can be improved. Productivity improvements from things such as sharing customer service processes, purchasing systems, distribution and manufacturing systems, and other processes can lead to great synergies and success. Operations accounts for 60 to 80 percent of the direct expenses that limit the profit of most firms. Without these operations synergies, designed and implemented by executives with a keen understanding of the concepts in this book, companies are often left with expensive debt, disappointed customers and shareholders, and pressure on the bottom line—on earnings.

Finally, you may be interested in a career in operations and supply chain management. Well, you are not alone. Professional organizations such as APICS, the Institute for Supply Management, and the Council of Supply Chain Management Professionals have well over 200,000 members participating in regular monthly meetings, annual conferences, and certification programs. Entry-level jobs might be as a forecast strategist, project manager, inventory control manager, production supervisor, purchasing manager, logistics manager, or warehouse specialist. In addition, top operations students may obtain their initial jobs with consulting firms, working as business process analysts and system design specialists.

We encourage you to talk to your instructor about what you want to get out of the course. What are your career aspirations, and how do they relate to the material in this course? Write your instructor a short e-mail describing what you want to do in the future—this is invaluable information for tailoring the material in the course to your needs. As you work through the text, share your experiences and insights with the class. Being an active student is guaranteed to make your experience more valuable and interesting.

ACKNOWLEDGMENTS

Special thanks to those who develop and market the book: Chuck Synovec, Director; Noelle Bathurst, Portfolio Manager; Harper Christopher, Executive Marketing Manager; Ryan McAndrews, Product Developer; Fran Simon, Content Project Manager; Jamie Koch, Assessment Project Manager; and Egzon Shaqiri, Senior Designer. The time spent talking to faculty at the conferences is appreciated. Also, thanks to Gary Black who keeps Connect current.

Thanks also to the many loyal adopters of the book. Tim Smunt (University of Wisconsin–Milwaukee) and Don Sheldon (Binghamton University SUNY) were particularly helpful with input for this edition.

Last, but certainly not least, we thank our families. We have stolen countless hours away for this project; time that would otherwise be spent with them. We sincerely appreciate their support.

F. Robert Jacobs
Richard B. Chase

A NOTE TO INSTRUCTORS

Operations and Supply Chain Management: The Core derives its title from a combination of ideas and trends. The book is designed to be lean and focused, much in the tradition of the concepts taught in the book. The topics selected are the result of the study of the syllabi of dozens of representative U.S. universities. There are a wide variety of topics covered, many more than could be covered in a single course. Our “big book,” *Operations and Supply Chain Management*, is comprehensive and is intended for those who want to pick and choose topics that best fit the objectives of their course. The “Core” book covers the topics most commonly included in these courses and has material sufficient for a 12- to 15-week course.

As is well known in the field, success for companies today requires successfully managing the entire supply flow, from the sources of the firm, through the value-added processes of the firm, and on to the customers of the firm.

In *Operations and Supply Chain Management: The Core 5e*, we take students to the center of the business and focus on the core concepts and tools needed to ensure that these processes run smoothly.

Discussion of Fifth Edition Revisions

Many of the revisions to the fifth edition have been driven by our focus on supply chain analytics. Supply chain analytics involves the analysis of data to better solve business problems. We recognize that this is not really new since data have always been used to solve business problems. But what *is* new is the reality that there are a great deal more data now available for decision making.

In the past, most analysis involved the generation of standard and ad hoc reports that summarized the current state of the firm. Software allowed query and “drill down” analysis to the level of the individual transaction, useful features for understanding what happened in the past. Decision making was typically left to the decision maker based on judgment or simple alerting rules. The new “analytics” movement takes this to a new level using statistical analysis, forecasting to extrapolate what to expect in the future, and even optimization, possibly in real time, to support decisions.

In this new edition we have refined the 11 Analytics Exercises that have proven to be so popular in our books. These Analytics Exercises use settings that are modern and familiar to students taking the course. They include Starbucks, cell phones, notebook computers, Taco Bell Restaurant, Tesla, a retail Web site–based company, and industrial products that are sourced from China/Taiwan and sold globally.

In this book, all of the chapters have been designed to be independent. We have put much effort into the organization of the book, but recognize that our organization might not align with the way you are using the material in your course. In addition, many of you may custom publish a version of the book to exactly meet your needs. The chapters have been designed to allow this type of customization.

The chapters are all now tightly organized by special learning objectives. The learning objectives for the chapter are defined at the start. Special contiguous sections are designed to cover each objective. The chapter summary and discussion and objective questions are also organized by learning objective. This new organization allows material to be assigned at the level of learning objective. If the desire might be to skip some advanced techniques, for example, this can be done easily by not assigning the specific learning objective. This allows considerable flexibility in how the material is used in a class.

The material has also been adapted to work well with electronic media, since this is now becoming the media of choice at many universities.

TECHNOLOGY

McGraw-Hill Connect Features

Connect offers a number of powerful tools and features to make managing assignments easier so faculty can spend more time teaching. With Connect, students can engage with their coursework anytime and anywhere making the learning process more accessible and efficient. Connect offers you the features described below.

Instructor Library

The Connect 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 Instructor Library includes:

- PowerPoint Slides
- Text Figures
- Instructor's Solutions Manual
- Test Banks
- Excel Templates

Student Study Center

The Connect Student Study Center is the place for students to access additional resources. The Student Study Center offers students quick access to study and review material.

Tegrity Campus: Lectures 24/7



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 that are immediately supported by your lecture. To learn more about Tegrity, watch a two-minute Flash demo at www.tegrity.com.

OPERATIONS MANAGEMENT AND THE AACSB

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 and Supply Chain Management* is designed specifically to support your assurance of learning initiatives with a simple yet powerful solution.

Each test bank question for *Operations and Supply Chain 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, presentation, and 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 and Supply Chain 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 standards Assessment of Learning Standards.

The statements contained in *Operations and Supply Chain 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 and Supply Chain 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.

McGraw-Hill Customer Experience Contact Information

At McGraw-Hill, we understand that getting the most from new technology can be challenging. That's why our services don't stop after you purchase our products. You can e-mail our Product Specialists 24 hours a day to get product-training online. Or you can search our knowledge bank of Frequently Asked Questions on our support Web site. For Customer Support, call **800-331-5094** or visit mpss.mhhe.com. One of our Technical Support Analysts will be able to assist you in a timely fashion.



connect®

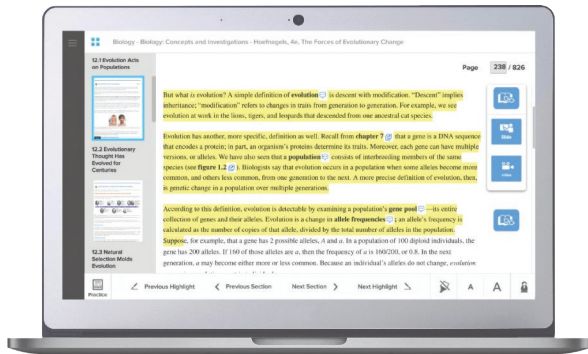
Students—study more efficiently, retain more and achieve better outcomes. Instructors—focus on what you love—teaching.

SUCCESSFUL SEMESTERS INCLUDE CONNECT

FOR INSTRUCTORS

You're in the driver's seat.

Want to build your own course? No problem. Prefer to use our turnkey, prebuilt course? Easy. Want to make changes throughout the semester? Sure. And you'll save time with Connect's auto-grading too.



65%

Less Time Grading

They'll thank you for it.

Adaptive study resources like SmartBook® help your students be better prepared in less time. You can transform your class time from dull definitions to dynamic debates. Hear from your peers about the benefits of Connect at www.mheducation.com/highered/connect.

Make it simple, make it affordable.

Connect makes it easy with seamless integration using any of the major Learning Management Systems—Blackboard®, Canvas, and D2L, among others—to let you organize your course in one convenient location. Give your students access to digital materials at a discount with our inclusive access program. Ask your McGraw-Hill representative for more information.



©Hill Street Studios/Tobin Rogers/Blend Images LLC



Solutions for your challenges.

A product isn't a solution. Real solutions are affordable, reliable, and come with training and ongoing support when you need it and how you want it. Our Customer Experience Group can also help you troubleshoot tech problems—although Connect's 99% uptime means you might not need to call them. See for yourself at status.mheducation.com

FOR STUDENTS

Effective, efficient studying.

Connect helps you be more productive with your study time and get better grades using tools like SmartBook, which highlights key concepts and creates a personalized study plan. Connect sets you up for success, so you walk into class with confidence and walk out with better grades.

“I really liked this app—it made it easy to study when you don't have your textbook in front of you.”

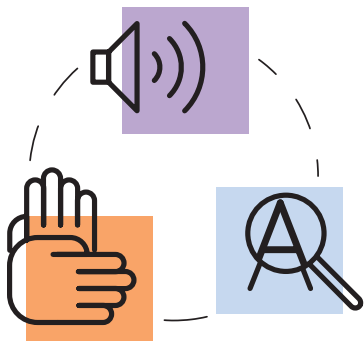
- Jordan Cunningham,
Eastern Washington University

Study anytime, anywhere.

Download the free ReadAnywhere app and access your online eBook when it's convenient, even if you're offline. And since the app automatically syncs with your eBook in Connect, all of your notes are available every time you open it. Find out more at www.mheducation.com/readanywhere

No surprises.

The Connect Calendar and Reports tools keep you on track with the work you need to get done and your assignment scores. Life gets busy; Connect tools help you keep learning through it all.



13	14
Chapter 12 Quiz	Chapter 11 Quiz
Chapter 13 Evidence of Evolution	Chapter 11 DNA Technology
	Chapter 7 Quiz
	Chapter 7 DNA Structure and Gene...
	and 7 more...

Learning for everyone.

McGraw-Hill works directly with Accessibility Services Departments and faculty to meet the learning needs of all students. Please contact your Accessibility Services office and ask them to email accessibility@mheducation.com, or visit www.mheducation.com/about/accessibility.html for more information.



©Shutterstock/wavebreakmedia

Walkthrough

Major Study and Learning Features

The following section highlights the key features developed to provide you with the best overall text available. We hope these features give you maximum support to learn, understand, and apply operations concepts.

Chapter Opener



Opening Vignettes

Each chapter opens with a short vignette to set the stage and help pique students' interest in the material about to be studied. A few examples include:

- Alphabet (Google) Operations Strategy, Chapter 2
- From Bean to Cup: Starbucks Global Supply Chain Challenge, Chapter 3
- Inside the iPhone X, Chapter 9
- Boeing 787 Dreamliner, Chapter 13

In the context of major business functions, operations and supply chain management involves specialists in product design, purchasing, manufacturing, service operations, logistics, and distribution. These specialists are mixed and matched in many different ways depending on the product or service. For a firm that sells electronic devices, like Apple, these are the functions responsible for designing the devices, acquiring materials, coordinating equipment resources to convert material to products, moving the product, and exchanging the final product with the customer. Some

firms are focused on services, such as a hospital. Here, the context involves managing resources, including the operating rooms, labs, and hospital beds used to nurse patients back to health. In this context, acquiring materials, moving patients, and coordinating resource use are keys to success. Other firms are more specialized, such as Amazon. Here, purchasing, Web site services, logistics, and distribution need to be carefully coordinated for success.

In our increasingly interconnected and interdependent global economy, the process of delivering finished goods, services, and supplies from one place to another is accomplished by means of mind-boggling technological innovation, clever new applications of old ideas, seemingly magical mathematics, powerful software, and old-fashioned concrete, steel, and muscle. This book is about doing this at low cost while meeting the requirements of demanding customers. Success involves the clever integration of a great operations-related strategy, processes that can deliver the products and services, and analytics that support the ongoing decisions needed to manage the firm. Our goal in this book is to introduce students to basic operations and supply chain concepts so they understand how things should be done and the importance of these functions to the success of the firm.



©franz12/Shutterstock

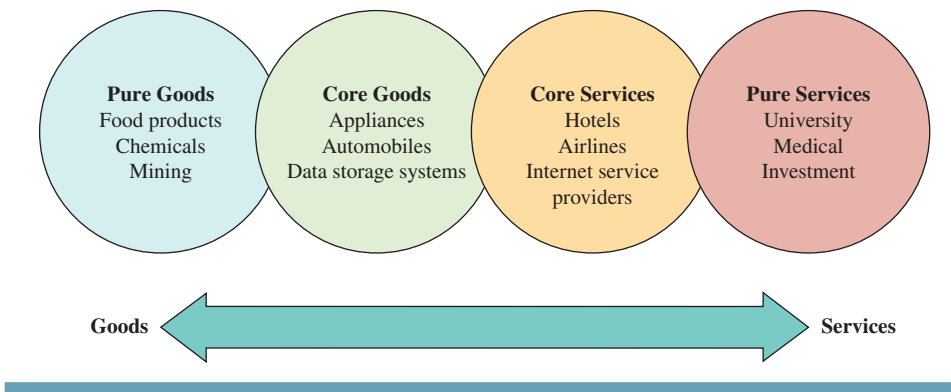


Photos and Exhibits

Photos and exhibits in the text enhance the visual appeal and clarify text discussions. Many of the photos illustrate additional examples of companies that utilize the operations and supply chain concepts in their business.

exhibit 1.3

The Goods–Services Continuum



MARSHMALLOW CANDY PEEPS CHICKS GET A QUALITY CONTROL CHECK AS THEY MOVE DOWN A CONVEYOR BELT INSIDE THE JUST BORN INC. MANUFACTURING FACILITY IN BETHLEHEM, PENNSYLVANIA.

©Mike Mergen/Bloomberg/Getty Images

Concept Connections

Concept Connections draws together various end-of-chapter sections including Key Terms, Solved Problems, Discussion Questions, Objective Questions, Cases, Analytics Exercises, and Practice Exams.

CONCEPT CONNECTIONS

LO1-1 Identify the elements of operations and supply chain management (OSCM).

- Processes are used to implement the strategy of the firm.
- Analytics are used to support the ongoing decisions needed to manage the firm.

Operations and supply chain management (OSCM) The design, operation, and improvement of the systems that create and deliver the firm's primary products and services.

Process One or more activities that transform inputs into outputs.

Product-service bundling When a firm builds service activities into its product offerings to create additional value for the customer.

Solved Problems

Representative problems are placed at the end of appropriate chapters. Each includes a worked-out solution giving students a review before solving problems on their own.

SOLVED PROBLEMS

SOLVED PROBLEM 1

Quick Lube Inc. operates a fast lube and oil change garage. On a typical day, customers arrive at the rate of three per hour, and lube jobs are performed at an average rate of one every 15 minutes. The mechanics operate as a team on one car at a time.

Assuming Poisson arrivals and exponential service, find:

- The utilization of the lube team.
- The average number of cars in line.
- The average time a car waits before it is lubed.
- The total time it takes to go through the system (that is, waiting in line plus lube time).

Solution

$$\lambda = 3, \mu = 4$$

$$a. \text{ Utilization } \rho = \frac{\lambda}{\mu} = \frac{3}{4} = 75 \text{ percent.}$$

$$b. L_q = \frac{\lambda^2}{\mu(\mu - \lambda)} = \frac{3^2}{4(4 - 3)} = \frac{9}{4} = 2.25 \text{ cars in line.}$$

$$c. W_q = \frac{L_q}{\lambda} = \frac{2.25}{3} = 0.75 \text{ hour, or 45 minutes.}$$

$$d. W_s = \frac{L_s}{\lambda} = \frac{\lambda}{\mu - \lambda} / \lambda = \frac{3}{4 - 3} / 3 = 1 \text{ hour (waiting + lube).}$$



Excel:
Queue

Practice Exam

The practice exam includes many straightforward review questions, but also has a selection that tests for mastery and integration/application level understanding—that is, the kind of questions that make an exam challenging.

PRACTICE EXAM

1. A strategy that is designed to meet current needs without compromising the ability of future generations to meet their needs.
2. The three criteria included in a triple bottom line.
3. The seven operations and supply chain competitive dimensions.
4. It is probably most difficult to compete on this major competitive dimension.
5. This occurs when a company seeks to match what a competitor is doing while maintaining its existing competitive position.
6. A criterion that differentiates the products or services of one firm from those of another.
7. A screening criterion that permits a firm's products to be considered as possible candidates for purchase.
8. A diagram showing the activities that support a company's strategy.
9. A measure calculated by taking the ratio of output to input.

Answers to Practice Exam 1. Sustainable 2. Social, economic, environmental 3. Cost or price, quality, delivery speed, delivery reliability, coping with changes in demand, flexibility and speed of new-product introduction, other product-specific criteria 4. Cost 5. Straddling 6. Order winner 7. Order qualifier 8. Activity-system map 9. Productivity

Cases

Cases allow students to think critically about issues discussed in the chapter. Cases include:

The Tao of Timbuk2, Chapter 2

Shouldice Hospital—A Cut Above, Chapter 4

Pro Fishing Boats—A Value Stream Mapping Exercise, Chapter 12

CASE: THE TAO OF TIMBUK2*

“Timbuk2 is more than a bag. It's more than a brand. Timbuk2 is a bond. To its owner, a Timbuk2 bag is a dependable, everyday companion. We see fierce, emotional attachments form between Timbuk2 customers and their bags all the time. A well-worn Timbuk2 bag has a certain patina—the stains and scars of everyday urban adventures. Many Timbuk2 bags are worn daily for a decade or more, accompanying the owner through all sorts of defining life events. True to our legend of ‘indestructibility,’ it's not uncommon for a Timbuk2 bag to outlive jobs, personal relationships, even pets. This is the Tao of Timbuk2.”

What makes Timbuk2 so unique? Visit the Web site at www.timbuk2.com and see for yourself. Each bag is custom designed by the customer on the Web site. After the customer selects the basic bag configuration and size, colors for each of the various panels are presented; various lines, logos,

production line to make it as efficient as possible while producing the highest-quality messenger bags available.

The local manufacturing is focused on the custom messenger bag. For these bags, orders are taken over the Internet. Customers are offered many configuration, size, color, pocket, and strap options. The bag is tailored to the exact specifications of the customer on the Timbuk2 assembly line in San Francisco and sent via overnight delivery directly to the customer.

Recently, Timbuk2 has begun making some of its new products in China, which is a concern to some of its long-standing customers. The company argues that it has designed its new products to provide the best possible features, quality, and value at reasonable prices and stresses that these new products are designed in San Francisco. Timbuk2 argues that the new bags are much more complex to build and require

Analytics Exercises

There are so much more data now available for decision making. The analytics movement takes this to a new level using statistical analysis to extrapolate what to expect in the future to support operations and supply chain decisions. A series of 11 analytics exercises are spread through the chapters. These include:

- Forecasting Supply Chain Demand: Starbucks Corporation, Chapter 3
- Designing a Manufacturing Process: Notebook Computer Assembly Line, Chapter 6
- Processing Customer Orders: Analyzing a Taco Bell Restaurant, Chapter 7
- Global Sourcing Decisions—Grainger: Reengineering the China/U.S. Supply Chain, Chapter 13

ANALYTICS EXERCISE: DESIGNING A MANUFACTURING PROCESS

A Notebook Computer Assembly Line

A manufacturing engineering section manager is examining the prototype assembly process sheet (shown in Exhibit 6.8) for his company's newest subnotebook computer model. With every new model introduced, management felt that the assembly line had to increase productivity and lower costs, usually resulting in changes to the assembly process. When a new model is designed, considerable attention is directed toward reducing the number of components and simplifying parts production and assembly requirements. This new computer was a marvel of high-tech, low-cost innovation and should give the company an advantage during the upcoming fall/winter selling season.

Production of the subnotebook is scheduled to begin in 10 days. Initial production for the new model is to be 150 units per day, increasing to 250 units per day the following week (management thought that eventually production would reach 300 units per day). Assembly lines at the plant normally are staffed by 10 operators who work at a 14.4-meter-long assembly line. The line is organized in a straight line with workers shoulder to shoulder on one side. The line can accommodate up to 12 operators if there is a need. The line normally operates for 7.5 hours a day (employees work from 8:15 A.M. to 5:00 P.M. and regular hours include one hour of unpaid lunch and 15 minutes of scheduled breaks). It is possible to run one, two, or three hours of overtime, but employees need at least three days' notice for planning purposes.

CONTENTS IN BRIEF

- 1 Operations and Supply Chain Management 2**
Analytics Exercise: Comparing Companies Using Wall Street Efficiency Measures 23
- 2 Strategy and Sustainability 24**
- 3 Forecasting 44**
Analytics Exercise: Forecasting Supply Chain Demand—Starbucks Corporation 89
- 4 Strategic Capacity Management 92**
- 4a Learning Curves 114**
- 5 Projects 126**
Analytics Exercise: Product Design Project 164
- 6 Manufacturing Processes 166**
Analytics Exercise: Designing a Manufacturing Process 195
- 6a Break-Even Analysis 198**
- 7 Service Processes 202**
Analytics Exercise: Processing Customer Orders 235
- 8 Sales and Operations Planning 238**
Analytics Exercise: Developing an Aggregate Plan—Bradford Manufacturing 261
- 9 Material Requirements Planning 264**
Analytics Exercise: An MRP Explosion—Brunswick Motors 296
- 10 Quality Management and Six Sigma 298**
Analytics Exercise: Quality Management—Tesla 345
- 11 Inventory Management 348**
Analytics Exercise: Inventory Management at Big10Sweaters.com 392
- 12 Lean Supply Chains 396**
- 13 Global Sourcing and Procurement 428**
Analytics Exercise: Global Sourcing Decisions—Grainger: Reengineering the China/U.S. Supply Chain 451
- 14 Location, Logistics, and Distribution 454**
Analytics Exercise: Distribution Center Location—Grainger: Reengineering the China/U.S. Supply Chain 478
- APPENDICES**
-
- A Linear Programming Using the Excel Solver 481**
-
- B Answers to Selected Objective Questions 504**
-
- C Present Value Table 506**
-
- D Negative Exponential Distribution: Values of e^{-x} 507**
-
- E Areas of the Cumulative Standard Normal Distribution 508**
-
- NAME INDEX 509**
- SUBJECT INDEX 510**

CONTENTS

1 OPERATIONS AND SUPPLY CHAIN MANAGEMENT 2

- Strategy, Processes, and Analytics 2
- What Is Operations and Supply Chain Management? 4
 - Operations and Supply Chain Processes* 6
 - Differences between Services and Goods* 7
 - The Goods–Services Continuum* 8
 - Product–Service Bundling* 9
- Efficiency, Effectiveness, and Value 9
 - How Does Wall Street Evaluate Efficiency?* 10
- Careers in Operations and Supply Chain Management 14
 - Chief Operating Officer* 16
- Historical Development of Operations and Supply Chain Management 16
 - Current Issues in Operations and Supply Chain Management* 19
 - Concept Connections* 19
 - Discussion Questions* 21
 - Objective Questions* 21
 - Analytics Exercise: Comparing Companies Using Wall Street Efficiency Measures* 23
 - Practice Exam* 23

2 STRATEGY AND SUSTAINABILITY 24

- Alphabet (Google) Operations Strategy 24
- A Sustainable Operations and Supply Chain Strategy 25
 - What Is Operations and Supply Chain Strategy? 27
 - Competitive Dimensions* 28
 - The Notion of Trade-Offs* 30
 - Order Winners and Order Qualifiers: The Marketing–Operations Link* 31
- Strategies Are Implemented Using Operations and Supply Chain Activities—IKEA's Strategy 31
 - Assessing the Risk Associated with Operations and Supply Chain Strategies 33
 - Risk Management Framework* 34
- Productivity Measurement 34
 - Concept Connections* 37
 - Solved Problem* 38
 - Discussion Questions* 39
 - Objective Questions* 39
 - Case: The Tao of Timbuk2* 42
 - Practice Exam* 43

3 FORECASTING 44

- From Bean to Cup: Starbucks Global Supply Chain Challenge 44
 - Forecasting in Operations and Supply Chain Management 46
 - Quantitative Forecasting Models 47
 - Components of Demand* 48
 - Time Series Analysis* 49
 - Simple Moving Average* 50
 - Weighted Moving Average* 52
 - Exponential Smoothing* 53
 - Exponential Smoothing with Trend* 55
 - Linear Regression Analysis* 57
 - Decomposition of a Time Series* 61
 - Forecast Errors* 64
 - Sources of Error* 64
 - Measurement of Error* 65
 - Causal Relationship Forecasting* 68
 - Multiple Regression Analysis* 69
 - Qualitative Techniques in Forecasting 70
 - Market Research* 70
 - Panel Consensus* 70
 - Historical Analogy* 70
 - The Delphi Method* 71
- Web-Based Forecasting: Collaborative Planning, Forecasting, and Replenishment (CPFR) 71
 - Concept Connections* 73
 - Solved Problems* 75
 - Discussion Questions* 80
 - Objective Questions* 81
 - Analytics Exercise: Forecasting Supply Chain Demand—Starbucks Corporation* 89
 - Practice Exam* 90

4 STRATEGIC CAPACITY MANAGEMENT 92

- Tesla—Manufacturing Capacity for the Model 3 93
 - Capacity Management in Operations and Supply Chain Management 94
 - Capacity Planning Concepts* 95
 - Economies and Diseconomies of Scale* 95
 - Capacity Focus* 96
 - Capacity Flexibility* 96
 - Capacity Planning* 97

Considerations in Changing Capacity 97
Determining Capacity Requirements 99
 Using Decision Trees to Evaluate Capacity Alternatives 101
 Planning Service Capacity 104
Capacity Planning in Services versus Manufacturing 104
Capacity Utilization and Service Quality 105
 Concept Connections 106 *Solved Problem* 107
 Discussion Questions 109 *Objective Questions* 109
Case: Shouldice Hospital—A Cut Above 111
Practice Exam 113

4A LEARNING CURVES 114

The Learning Curve 114
 How Are Learning Curves Modeled? 116
Learning Curve Tables 119
 Concept Connections 122 *Solved Problems* 122
 Discussion Questions 123 *Objective Questions* 124

5 PROJECTS 126

Can a 15-Story Hotel Be Built in Less Than a Week? 126
 What Is Project Management? 127
Organizing the Project Team 129
Organizing Project Tasks 131
 Managing Projects 132
Earned Value Management (EVM) 134
 Network-Planning Models 138
Critical Path Method (CPM) 138
CPM with Three Activity Time Estimates 142
Time–Cost Models and Project Crashing 145
 Project Management Information Systems 150
 Concept Connections 151 *Solved Problems* 152
 Discussion Questions 157 *Objective Questions* 157
 Analytics Exercise: Product Design Project 164
 Practice Exam 165

6 MANUFACTURING PROCESSES 166

Three-Dimensional Printing—The Technology Could Be Used to Make Parts That Perform Better and Cost Less 166
 Production Processes 167
 Production Process Mapping and Little’s Law 170
 How Production Processes Are Organized 173
Designing a Production System 175
Assembly-Line and Continuous Process Layouts 178

Assembly-Line Design 178
Splitting Tasks 182
Flexible and U-Shaped Line Layouts 182
 Concept Connections 183 *Solved Problems* 185
 Discussion Questions 189 *Objective Questions* 190
 Advanced Problem 194
 Analytics Exercise: Designing a Manufacturing Process 195
 Practice Exam 197

6A BREAK-EVEN ANALYSIS 198

Solved Problems 199 *Objective Questions* 201

7 SERVICE PROCESSES 202

Amazon—A Retailer That Operates at a Different Level 202
 The Nature of Services 203
An Operational Classification of Services 204
Designing Service Organizations 204
Structuring the Service Encounter: Service–System Design Matrix 205
Web Platform Businesses 206
 Service Blueprinting and Fail-Safing 208
 Economics of the Waiting Line Problem 210
The Practical View of Waiting Lines 210
The Queuing System 212
Waiting Lines and Servers 216
Waiting Line Models 219
Computer Simulation of Waiting Lines 224
 Concept Connections 227 *Solved Problems* 229
 Discussion Questions 230 *Objective Questions* 231
 Analytics Exercise: Processing Customer Orders 235
 Practice Exam 237

8 SALES AND OPERATIONS PLANNING 238

What Is Sales and Operations Planning? 240
Overview of Sales and Operations Planning Activities 240
The Aggregate Operations Plan 242
Production Planning Environment 243
 Relevant Costs 245
 Aggregate Planning Techniques 246
A Cut-and-Try Example: The JC Company 246
 Yield Management 248
Operating Yield Management Systems 252

Concept Connections 253 *Solved Problems* 254
Discussion Questions 257 *Objective Questions* 257
Analytics Exercise: Developing an Aggregate Plan—
Bradford Manufacturing 261
Practice Exam 263

9 MATERIAL REQUIREMENTS PLANNING 264

Inside the iPhone X 264
 Understanding Material Requirements
 Planning 266
Where MRP Can Be Used 267
Master Production Scheduling 268
Time Fences 269
 Material Requirements Planning System
 Structure 270
Demand for Products 270
Bill-of-Materials 271
Inventory Records 273
The MRP Computer Program 274
 An Example Using MRP 275
Forecasting Demand 275
Developing a Master Production Schedule 276
Bill-of-Materials (Product Structure) 276
Inventory Records 277
Performing the MRP Calculations 277
 Lot Sizing in MRP Systems 281
Lot-for-Lot 281
Economic Order Quantity 282
Least Total Cost 283
Least Unit Cost 283
Choosing the Best Lot Size 284
Concept Connections 285 *Solved Problems* 286
Discussion Questions 291 *Objective Questions* 292
Analytics Exercise: An MRP Explosion—Brunswick
Motors 296
Practice Exam 297

10 QUALITY MANAGEMENT AND SIX SIGMA 298

Disney—An Obsession with Quality and
 Innovation 298
 Total Quality Management 300
Quality Specifications and Quality Costs 301
 ISO 9000 and ISO 14000 304
External Benchmarking for Quality Improvement 307
 Six Sigma Quality 307
Six Sigma Methodology 308

Analytical Tools for Six Sigma 309
 Statistical Quality Control 312
Understanding and Measuring Process Variation 314
Process Capability 315
 Statistical Process Control Procedures 321
Process Control with Attribute Measurements: Using
p-Charts 321
Process Control with Attribute Measurements: Using
c-Charts 324
Process Control with Variable Measurements:
Using \bar{X} - and R-Charts 325
How to Construct \bar{X} - and R-Charts 326
 Acceptance Sampling 329
Design of a Single Sampling Plan for Attributes 329
Operating Characteristic Curves 331
Concept Connections 332 *Solved Problems* 335
Discussion Questions 338 *Objective Questions* 339
Analytics Exercise: Quality Management—Tesla 345
Practice Exam 346

11 INVENTORY MANAGEMENT 348

Amazon—The Master of Inventory Management 348
 Understanding Inventory Management 350
Definition of Inventory 352
Purposes of Inventory 352
Inventory Costs 353
Independent versus Dependent Demand 354
 Inventory Systems 355
A Single-Period Inventory Model 355
Multiperiod Inventory Systems 359
Fixed-Order Quantity Models 360
Establishing Safety Stock Levels 363
Fixed-Order Quantity Model with Safety Stock 364
Fixed-Time Period Models 368
Fixed-Time Period Model with Safety Stock 368
Inventory Turn Calculations 370
The Price-Break Model 371
 Inventory Planning and Accuracy 373
ABC Classification 374
Inventory Accuracy and Cycle Counting 375
Concept Connections 377 *Solved Problems* 379
Discussion Questions 383 *Objective*
Questions 383
Analytics Exercise: Inventory Management at
Big10Sweaters.com 392
Practice Exam 395

12 LEAN SUPPLY CHAINS 396

- Toyota—New Global Architecture 396
- Lean Production 397
- The Toyota Production System* 399
- Lean Supply Chains 400
- Value Stream Mapping 402
- Lean Supply Chain Design Principles 404
- Lean Concepts* 406
- Lean Production Schedules* 407
- Lean Supply Chains* 412
- Lean Services 413
 - Concept Connections* 415 *Solved Problems* 417
 - Discussion Questions* 421 *Objective Questions* 421
 - Case: Quality Parts Company* 423
 - Case: Value Stream Mapping* 424
 - Case: Pro Fishing Boats—A Value Stream Mapping Exercise* 426
 - Practice Exam* 427

13 GLOBAL SOURCING AND PROCUREMENT 428

- Boeing 787 Dreamliner—Assembled in South Carolina from Components Sourced from around the World 428
- Strategic Sourcing 429
- The Bullwhip Effect* 431
- Supply Chain Uncertainty Framework* 432
- Outsourcing 435
- Logistics Outsourcing* 436
- Framework for Supplier Relationships* 436
- Green Sourcing* 438
- Total Cost of Ownership 441
- Measuring Sourcing Performance 444
 - Concept Connections* 446 *Discussion Questions* 447 *Objective Questions* 448
 - Analytics Exercise: Global Sourcing Decisions—Grainger: Reengineering the China/U.S. Supply Chain* 451
 - Practice Exam* 453

14 LOCATION, LOGISTICS, AND DISTRIBUTION 454

- FedEx—Speed Is Hidden in Its Logo 454
- Logistics 455
- Decisions Related to Logistics 456
- Transportation Modes* 457
- Warehouse Design* 458
- Locating Logistics Facilities 458
- Plant Location Methods* 460
- Locating Service Facilities* 466
 - Concept Connections* 469 *Solved Problems* 470
 - Discussion Questions* 474 *Objective Questions* 475
 - Analytics Exercise: Distribution Center Location—Grainger: Reengineering the China/U.S. Supply Chain* 478
 - Practice Exam* 480

APPENDICES

-
- A** Linear Programming Using the Excel Solver 481
-
- B** Answers to Selected Objective Questions 504
-
- C** Present Value Table 506
-
- D** Negative Exponential Distribution: Values of e^{-x} 507
-
- E** Areas of the Cumulative Standard Normal Distribution 508
-

NAME INDEX 509

SUBJECT INDEX 510

Operations and Supply Chain Management: The Core



CHAPTER 1

OPERATIONS AND SUPPLY CHAIN MANAGEMENT

Learning Objectives

- LO1-1** Identify the elements of operations and supply chain management (OSCM).
- LO1-2** Evaluate the efficiency of the firm.
- LO1-3** Know the potential career opportunities in operations and supply chain management.
- LO1-4** Recognize the major concepts that define the operations and supply chain management field.

STRATEGY, PROCESSES, AND ANALYTICS

This book is about designing and operating processes that deliver a firm's goods and services in a manner that matches customers' expectations. Really successful firms have a clear and focused idea of how they intend to make money. Be it high-end products or services that are custom-tailored to the needs of a single customer or generic, inexpensive commodities that are bought largely on the basis of cost, competitively producing and distributing these products is a great challenge.

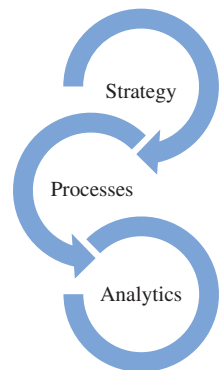
In the context of major business functions, operations and supply chain management involves specialists in product design, purchasing, manufacturing, service operations, logistics, and distribution. These specialists are mixed and matched in many different ways depending on the product or service. For a firm that sells electronic devices, like Apple, these are the functions responsible for designing the devices, acquiring materials, coordinating equipment resources to convert material to products, moving the product, and exchanging the final product with the customer. Some

firms are focused on services, such as a hospital. Here, the context involves managing resources, including the operating rooms, labs, and hospital beds used to nurse patients back to health. In this context, acquiring materials, moving patients, and coordinating resource use are keys to success. Other firms are more specialized, such as Amazon. Here, purchasing, Web site services, logistics, and distribution need to be carefully coordinated for success.

In our increasingly interconnected and interdependent global economy, the process of delivering finished goods, services, and supplies from one place to another is accomplished by means of mind-boggling technological innovation, clever new applications of old ideas, seemingly magical mathematics, powerful software, and old-fashioned concrete, steel, and muscle. This book is about doing this at low cost while meeting the requirements of demanding customers. Success involves the clever integration of a great operations-related strategy, processes that can deliver the products and services, and analytics that support the ongoing decisions needed to manage the firm. Our goal in this book is to introduce students to basic operations and supply chain concepts so they understand how things should be done and the importance of these functions to the success of the firm.



©franz12/Shutterstock



LO1-1 Identify the elements of operations and supply chain management (OSCM).

Operations and supply chain management (OSCM)

The design, operation, and improvement of the systems that create and deliver the firm's primary products and services.

WHAT IS OPERATIONS AND SUPPLY CHAIN MANAGEMENT?

Operations and supply chain management (OSCM) is defined as the design, operation, and improvement of the systems that create and deliver the firm's primary products and services. Like marketing and finance, OSCM is a functional field of business with clear line management responsibilities. OSCM is concerned with the management of the entire system that produces a product or delivers a service. Producing a product such as the Men's Nylon Supplex Parka or providing a service, such as a cellular phone account, involves a complex series of transformation processes.

Exhibit 1.1 shows a supply network for a Men's Nylon Supplex Parka sold on Web sites such as L.L.Bean or Land's End. We can understand the network by looking at the four color-coded paths. The blue path traces the activities needed to produce the Polartec insulation material used in the parkas. Polartec insulation is purchased in bulk, processed to get the proper finish, and then dyed prior to being checked for consistency—or grading—and color. It is then stored in a warehouse. The red path traces the production of the nylon, Supplex, used in the parkas. Using a petroleum-based polymer, the nylon is extruded and drawn into a yarnlike material. From here the green path traces the many steps required to fabricate the clothlike Supplex used to make the parkas. The yellow path shows the Supplex and Polartec material coming together and used to assemble the lightweight and warm parkas. The completed parkas are sent to a warehouse and on to the retailer's distribution center. The parkas are then picked and packed for shipment to individual customers.

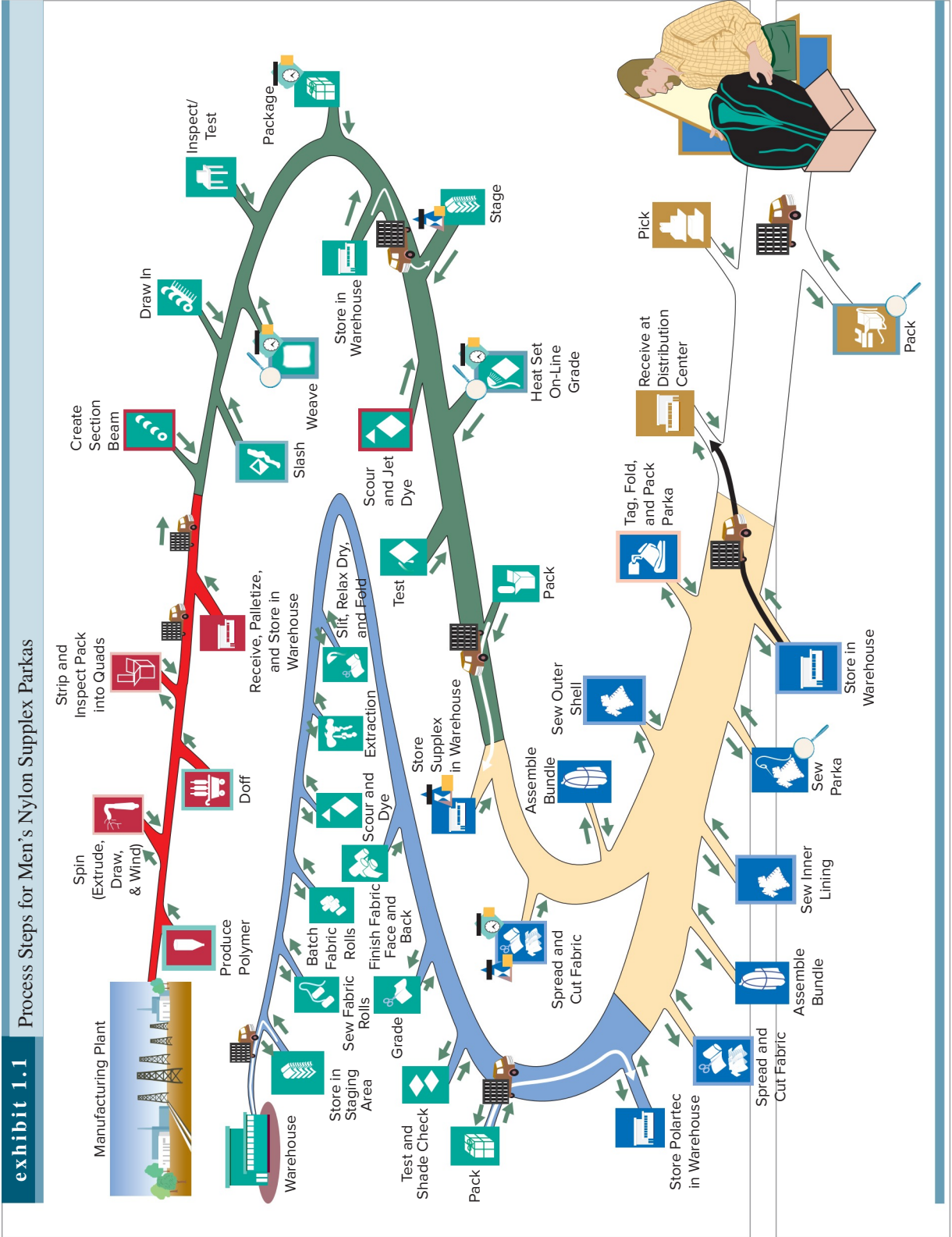
Think of the supply network as a pipeline through which material and information flow. There are key locations in the pipeline where material and information are stored for future use: Polartec is stored near the end of the blue pipeline; Supplex is stored near the end of the red pipeline. In both cases, fabric is cut prior to merging with the yellow pipeline. At the beginning of the yellow path, bundles of Supplex and Polartec are stored prior to their use in the fabrication of the parkas. At the end of the yellow path are the distribution steps, which involve storing to await orders, picking according to the actual customer order, packing, and finally shipping to the customer.

Networks such as this can be constructed for any product or service. Typically, each part of the network is controlled by different companies, including the nylon Supplex producer, the Polartec producer, the parka manufacturer, and the catalog sales retailer. All of the material is moved using transportation providers, ships and trucks in this case. The network also has a global dimension, with each entity potentially located in a different country.

Success in today's global markets requires a business strategy that matches the preferences of customers with the realities imposed by complex supply networks. A sustainable strategy that meets the needs of shareholders and employees and preserves the environment is critical.

In the context of our discussion, the terms *operations* and *supply chain* take on special meaning. *Operations* refers to manufacturing and service processes that are used to transform the resources employed by a firm into products desired by customers. For example, a manufacturing process would produce some type of physical product, such as an automobile or a computer. A service process





would produce an intangible product, such as a call center that provides information to customers stranded on the highway or a hospital that treats accident victims in an emergency room. Planning the use of these processes involves analyzing capacity, labor, and material needs over time. Ensuring quality and making ongoing improvements to these processes are needed to manage these processes.

Supply chain refers to processes that move information and material to and from the manufacturing and service processes of the firm. These include the logistics processes that physically move product, as well as the warehousing and storage processes that position products for quick delivery to the customer. Supply chain in this context refers to providing products and service to plants and warehouses at the input end and also to the supply of products and service to the customer on the output end of the supply chain.

We consider the topics included in this book to be the foundation or “core” material. Many other topics could be included, but these cover the fundamental concepts. All managers should understand these basic principles that guide the design of transformation processes. This includes understanding how different types of processes are organized, how to determine the capacity of a process, how long it should take a process to make a unit, how the quality of a process is monitored, and how information is used to make decisions related to the design and operation of these processes.

The field of operations and supply chain management is ever changing due to the dynamic nature of competing in global business and the constant evolution of information technology. So while many of the basic concepts have been around for years, their application in new and innovative ways is exciting. Internet technology has made the sharing of reliable real-time information inexpensive. Capturing information directly from the source through such systems as point-of-sale, radio-frequency identification tags, bar-code scanners, and automatic recognition has shifted the focus to understanding not only what all the information is saying but how good the decisions are that will use it.

Operations and Supply Chain Processes

Operations and supply chain **processes** can be conveniently categorized, particularly from the view of a producer of consumer products and services, as planning, sourcing, making, delivering, and returning. Exhibit 1.2 depicts where the processes are used in different parts of a supply chain. The following describes the work involved in each type of process.

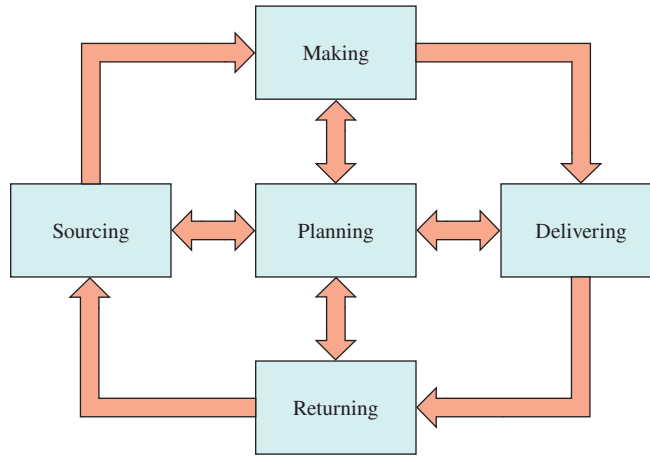
Process

One or more activities that transform inputs into outputs.

1. **Planning** consists of the processes needed to operate an existing supply chain strategically. Here, a firm must determine how anticipated demand will be met with available resources. A major aspect of planning is developing a set of metrics to monitor the supply chain so that it is efficient and delivers high quality and value to customers.
2. **Sourcing** involves the selection of suppliers that will deliver the goods and services needed to create the firm’s product. A set of pricing, delivery, and payment processes are needed together with metrics for monitoring and improving the relationships between partners of the firm. These processes include receiving shipments, verifying them, transferring them to manufacturing facilities, and authorizing supplier payments.
3. **Making** is where the major product is produced or the service is provided. The step requires scheduling processes for workers and coordinating material and other critical resources such as the equipment to support producing or providing the service. Metrics that measure speed, quality, and worker productivity are used to monitor these processes.

Supply Chain Processes

exhibit 1.2



4. **Delivering** is also referred to as a logistics process. Carriers are picked to move products to warehouses and customers, coordinate and schedule the movement of goods and information through the supply network, develop and operate a network of warehouses, and run the information systems that manage the receipt of orders from customers and the invoicing systems that collect payments from customers.
5. **Returning** involves processes for receiving worn-out, defective, and excess products back from customers and support for customers who have problems with delivered products. In the case of services, this may involve all types of follow-up activities that are required for after-sales support.

To understand the topic, it is important to consider the many different players that need to coordinate work in a typical supply chain. The steps of planning, sourcing, making, delivering, and returning are fine for manufacturing and can also be used for the many processes that do not involve the discrete movement and production of parts. In the case of a service firm such as a hospital, for example, supplies are typically delivered on a daily basis from drug and health care suppliers and require coordination among drug companies, local warehouse operations, local delivery services, and hospital receiving. Patients need to be scheduled into the services provided by the hospital, such as operations and blood tests. Other areas, such as the emergency room, need to be staffed to provide service on demand. The orchestration of all of these activities is critical to providing quality service at a reasonable cost.

Differences between Services and Goods

There are five essential differences between services and goods. The first is that a service is an *intangible* process that cannot be weighed or measured, whereas a good is a tangible output of a process that has physical dimensions. This distinction has important business implications since a service innovation, unlike a product innovation, cannot be patented. Thus, a company with a new concept must expand rapidly before competitors copy its procedures. Service intangibility also presents a problem for customers since, unlike with a physical product, customers cannot try it out and test it before purchase.

The second is that a service requires some degree of *interaction with the customer* for it to be a service. The interaction may be brief, but it must exist for the service to be complete. Where face-to-face service is required, the service facility must be designed to handle the customer's presence. Goods, on the other hand, are generally produced in a facility separate from the customer. They can be made according to a production schedule that is efficient for the company.

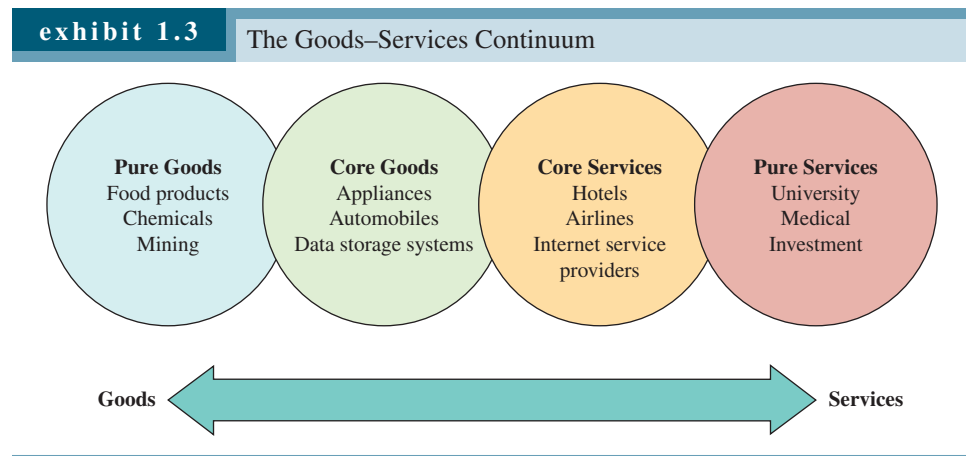
The third is that services, with the big exception of hard technologies such as automated teller machines (ATMs) and information technologies such as answering machines and automated Internet exchanges, are inherently *heterogeneous*—they vary from day to day and even hour by hour as a function of the attitudes of the customers and the servers. Thus, even highly scripted work, such as found in call centers, can produce unpredictable outcomes. Goods, in contrast, can be produced to meet very tight specifications day-in and day-out with essentially zero variability. In those cases where a defective good is produced, it can be reworked or scrapped.

The fourth is that services as a process are *perishable and time dependent*, and unlike goods, they can't be stored. You cannot “come back last week” for an air flight or a day on campus.

And fifth, the specifications of a service are defined and evaluated as a *package of features* that affect the five senses. These features relate to the location, decoration, and layout of the facility where the service is housed, for example. Other features are the training and attitude of employees, and the consistency of service performance. Such attributes as speed, privacy, and security are other features that define a service.

The Goods–Services Continuum

Almost any product offering is a combination of goods and services. In Exhibit 1.3, we show this arrayed along a continuum of “pure goods” to “pure services.” The continuum captures the main focus of the business and spans from firms that just produce products to those that only provide services. Pure goods industries have become low-margin commodity businesses, and in order to differentiate, they are often adding some services. Some examples are providing help with logistical aspects of stocking items, maintaining extensive information databases, and providing consulting advice.



Core goods providers already provide a significant service component as part of their businesses. For example, automobile manufacturers provide extensive spare parts distribution services to support repair centers at dealers.

Core service providers must integrate tangible goods. For example, your cable television company must provide cable hookup and repair services and also high-definition cable boxes. Pure services, such as those offered by a financial consulting firm, may need little in the way of facilitating goods, but what they do use—such as textbooks, professional references, and spreadsheets—are critical to their performance.

Product–Service Bundling

Product–service bundling refers to a company building service activities into its product offerings for its customers. Such services include maintenance, spare part provisioning, training, and in some cases, total systems design and R&D. A well-known pioneer in this area is IBM, which treats its business as a service business and views physical goods as a small part of the “business solutions” it provides its customers. Companies that are most successful in implementing this strategy start by drawing together the service aspects of the business under one roof in order to create a consolidated service organization. The service evolves from a focus on enhancing the product’s performance to developing systems and product modifications that support the company’s move up the “value stream” into new markets. This type of strategy might not be the best approach for all product companies, however. Firms that offer product–service bundles typically generate higher revenues, they tend to generate lower profits as a percentage of revenues when compared to focused firms. This is because they are often unable to generate revenues or margins high enough to cover the additional investment required to cover service-related costs.

Product–service bundling

When a firm builds service activities into its product offerings to create additional value for the customer.

EFFICIENCY, EFFECTIVENESS, AND VALUE

Compared with most of the other ways managers try to stimulate growth—via technology investments, acquisitions, and major market campaigns, for example—innovations in operations are relatively reliable and low cost. As a business student, you are perfectly positioned to come up with innovative operations-related ideas. You understand the big picture of all the processes that generate the costs and support the cash flow essential to the firm’s long-term viability.

Through this book, you will become aware of the concepts and tools now being employed by companies around the world as they craft efficient and effective operations. **Efficiency** means doing something at the lowest possible cost. Later in the book, we define this more thoroughly. But roughly speaking, the goal of an efficient process is to produce a good or provide a service by using the smallest input of resources. In general, these resources are the material, labor, equipment, and facilities used in the OSCM processes.

Effectiveness means doing the right things to create the most value for the customer. For example, to be effective at a grocery store it is important to have plenty of operating checkout lines even though they may often stand idle. This is a recognition that the customer’s time is valuable and that they do not like waiting to be served in the checkout line. Often maximizing effectiveness and efficiency at the same time creates conflict between the two goals. We see this trade-off every day in our lives. At the checkout lines, being efficient means using the fewest people possible to ring up customers. Being effective, though, means minimizing the amount of time customers need to wait in line.

LO1-2 Evaluate the efficiency of the firm.

Efficiency

Doing something at the lowest possible cost.

Effectiveness

Doing the right things to create the most value for the customer.