JAY HEIZER    BARRY RENDER    CHUCK MUNSON    PAUL GRIFFIN

# OPERATIONS MANAGEMENT

## SUSTAINABILITY AND SUPPLY CHAIN MANAGEMENT

### THIRD CANADIAN EDITION

AGRICULTURE

INDUSTRY

CONSUMERS

SUPERMARKET

This page intentionally left blank

# OPERATIONS MANAGEMENT

**THIRD CANADIAN EDITION**

## JAY HEIZER
Texas Lutheran University

## BARRY RENDER
Graduate School of Business, Rollins College

## CHUCK MUNSON
Carson College of Business, Washington State University

## PAUL GRIFFIN
Humber Institute of Technology and Advanced Learning

**Pearson**

To Kathryn Ann Heizer

—JH

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

—BR

To Suzanne, Alexandra, Kenna, Ryan, and
Robert Kathleen

—PG

# 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 five 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 honoured 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.

**Chuck Munson** Professor of Operations Management, Carson College of Business, Washington State University, Pullman, Washington. He received his BSBA *summa cum laude* in finance, along with his MSBA and Ph.D. in operations management, from Washington University in St. Louis. For two years, he served as Associate Dean for Graduate Programs in Business at Washington State. He also worked for three years as a financial analyst for Contel Telephone Corporation.

Professor Munson serves as a senior editor for *Production and Operations Management*, and he serves on the editorial review board of four other journals. He has published more than 25 articles in such journals as *Production and Operations Management, IIE Transactions, Decision Sciences, Naval Research Logistics, European Journal of Operational Research, Journal of the Operational Research Society,* and *Annals of Operations Research.* He is editor of the book *The Supply Chain Management Casebook: Comprehensive Coverage and Best Practices in SCM*, and he has co-authored the research monograph *Quantity Discounts: An Overview and Practical Guide for Buyers and Sellers*. He is also coauthor of *Managerial Decision Modeling with Spreadsheets* (4th edition), published by Pearson.

Dr. Munson has taught operations management core and elective courses at the undergraduate, MBA, and Ph.D. levels at Washington State University. He has also conducted several teaching workshops at international conferences and for Ph.D. students at Washington State University. His major awards include being a Founding Board Member of the Washington State University President's Teaching Academy (2004); winning the WSU College of Business Outstanding Teaching Award (2001 and 2015), Research Award (2004), and Service Award (2009 and 2013); and being named the WSU MBA Professor of the Year (2000 and 2008).

**Paul Griffin** Associate Dean, Business Degrees, Humber Institute of Technology & Advanced Learning, Toronto, Ontario, Canada. He received his Ph.D. in Management from the University of Bradford in the United Kingdom and has also achieved 18 professional designations, including Chartered Professional Accountant (CPA), Certified Management Accountant (CMA), Certified General Accountant (CGA), Certified Financial Planner (CFP), Fellow of the Canadian Securities Institute (FCSI), and several others.

Before joining academia, Dr. Griffin was engaged in the financial services sector for over 20 years and was most recently the National Director of Operations and Compliance at ING Canada. He remains an active member of several boards and committees, most notably the Insurance Institute of Canada's Ethics Advisory Board and the Financial Services Commission of Ontario's Advisory Board, and he serves as Chair of the Education Committee and Board of Directors for the Canadian Institute of Financial Planning. Before becoming Associate Dean at Humber, Dr. Griffin was a Professor and taught operations management, accounting, finance, and marketing. During that time, he received the Award of Excellence for Outstanding Academic Contribution.

Dr. Griffin continues to write for practitioner-targeted publications and develops a continuous stream of technical manuals, materials, and courses for both the academic and industrial sectors. He remains an active member of the Editorial Advisory Board for the *Journal of Financial Planning*.

# Brief Table of Contents

# Table of Contents

# Preface

Welcome to your operations management (OM) course and to the third Canadian edition of this textbook. This text presents a state-of-the-art view of the activities of the operations function from a Canadian perspective. Operations is an exciting and dynamic area of management that has a profound effect on the productivity of both services and manufacturing. Indeed, few other activities have so much impact on the quality of your life. The goal of this book is to present a broad introduction to the field of operations in a realistic, meaningful, and practical manner. OM includes a blend of subject areas, including accounting, industrial engineering, management, management science, and statistics. Whether you are pursuing a career in the operations field or not, you will likely be working with people in operations. Therefore, having a solid understanding of the role of operations in an organization is of substantial benefit to you. This text 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 buy a coffee at Tim Hortons, take a flight from Edmonton to Vancouver, place an order with Amazon.ca, or enter a Canadian hospital for medical care.

Although many readers of this book are not OM majors, students studying marketing, finance, accounting, and MIS will hopefully find the material both interesting and useful as they develop a fundamental working knowledge of the operations side of the firm.

## ABOUT THE THIRD CANADIAN EDITION

The goal of this third Canadian edition is to retain the features and strengths that have made this book so successful over the years while bringing a new Canadian perspective to the text. Readers will find examples of Canadian companies and success stories woven throughout the book with cases drawn from the manufacturing and service industry taken from both the private and public sectors. The text describes many Canadian locations and uses Canadian data when available. Readers can follow the story of the construction of a hockey arena as a recurring case study that touches upon many aspects of OM in a familiar setting. It is also important to acknowledge the global nature of today's business environment. Operations management is a discipline that encompasses both the local and the international, with global considerations affecting everything from location strategies to scheduling and transportation. This third Canadian edition therefore retains many of the best and most familiar U.S. and international examples.

## NEW TO THIS EDITION

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

**Five New Video Case Studies Featuring Alaska Airlines** In this edition we take you behind the scenes of Alaska Airlines, consistently rated as one of the top carriers in North America. This fascinating organization opened its doors—and planes—so we could examine leading-edge OM in the airline industry. We observe the quality program at Alaska Air (Chapter 6), the process analysis behind the airline's 20-minute baggage retrieval guarantee (Chapter 7), how Alaska empowers its employees (Chapter 10), the airline's use of Lean, 5s, kaizen, and Gemba walks (Chapter 16), and the complexities of scheduling (Module B). These videos, and other video case studies that feature real companies, can be found in MyLab Operations Management.

**New Sustainability in the Supply Chain Supplement 5** We have enhanced the coverage of sustainability in this edition with the inclusion of a brand-new supplement that covers the topics of corporate social responsibility, design and production for sustainability, and regulations and industry standards.

**Creating Your Own Excel Spreadsheets** We continue to provide two free decision support software programs, Excel OM for Windows and Mac and POM for Windows, to help

you and your students solve homework problems and case studies. These excellent packages are found in MyLab Operations Management's Download Center.

Many instructors also encourage students to develop their own Excel spreadsheet models to tackle OM issues. With this edition we provide numerous examples at chapter end on how to do so. "Creating Your Own Excel Spreadsheets" examples now appear in Chapters 2, 4, 8, 12, and Supplement 6, Supplement 7, and Modules A, and F. We hope these 8 samples will help expand students' spreadsheet capabilities.

**Expanding and Reordering Our Set of Homework Problems** We believe that a vast selection of quality homework problems, ranging from easy to challenging (denoted by one to four dots), is critical for both instructors and students. Instructors need a broad selection of problems to choose from for homework, quizzes, and exams—without reusing the same set from semester to semester. We take pride in having more problems than any other OM text. We added dozens of new problems this edition.

Further, with the majority of our adopters now using the MyLab Operations Management learning system in their classes, we have reorganized all the homework problems—both those appearing in the printed text and the additional homework problems that are available in MyLab Operations Management—by topic heading. We identify all problems by topic.

The list of all problems by topic also appears at the end of each boxed example as well as in the Rapid Review that closes each chapter. These handy references should make it easier to assign problems for homework, quizzes, and exams. A rich set of assignable problems and cases makes the learning experience more complete and pedagogically sound.

**Lean Operations** In previous editions we sought to explicitly differentiate the concepts of just-in-time, Lean, and the Toyota Production System in Chapter 16. However, there is significant overlap and interchangeability among those three concepts, so we have revised Chapter 16 to incorporate the three concepts into an overall concept of "Lean". The chapter suggests that students view Lean as a comprehensive integrated operations strategy that sustains competitive advantage and results in increased returns to all stakeholders.

In addition, the following changes have been made for the third Canadian edition:
- New section on strategic planning, core competencies, and outsourcing added to Chapter 2.
- Coverage of agile and waterfall approaches to project management have been revised in Chapter 3.
- New section on supply chain management in Chapter 4.
- Added coverage of sustainability and life cycle assessment (LCA) to Chapter 5.
- New section on ISO 9000 International Quality Standards in Chapter 6.
- Coverage of bottleneck analysis in Supplement 7 has been completely revised.
- Added coverage of supplier certification, contracting, and centralized purchasing to Chapter 11.
- Added section on warehouse storage to Supplement 11.
- Coverage of economic order quantity enhanced with new section on period order quantity in Chapter 14.
- Added coverage of finite and infinite loading to Chapter 15.
- Added coverage of Lean sustainability to Chapter 16.
- Added coverage of parallel redundancy to Chapter 17.
- New examples and case studies throughout the text.

**MyLab Operations Management Resources** In addition to our video case studies and our Excel OM and POM for Windows software, we provide the following resources in MyLab Operations Management:
- Excel OM data files: Prepared for specific examples, these files allow users to solve all the marked text examples without reentering data.
- Active Models: These are Excel-based OM simulations, designed to help students understand the quantitative methods shown in the textbook examples. Students may change the

data to see how the changes affect the answers. These files are available in the Download Center.
- Online Tutorial Chapters: "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 case studies: These case studies supplement the ones in the text.
- Virtual office hours videos: Professors Heizer, Render, and Munson walk students through the Solved Problems in a series of 5- to 20-minute explanations.

# ACKNOWLEDGMENTS

# Operations and Productivity

## Learning Objectives

**LO1** Define *operations management* **2**

**LO2** Explain the distinction between goods and services **9**

**LO3** Explain the difference between production and productivity **11**

**LO4** Compute single-factor productivity **12**

**LO5** Compute multifactor productivity **13**

**LO6** Identify the critical variables in enhancing productivity **14**

## Operations Management at Hard Rock Cafe

**Operations managers throughout the world are producing products daily to provide for the well-being of society. These products take on a multitude of forms, including auto parts at Magna International, motion pictures at DreamWorks Studios, rides at Disney World, and 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 Magna International, DreamWorks, Disney, or Hard Rock—is demanding.**

Orlando-based Hard Rock Cafe opened its first restaurant in London in 1971, making it over four decades 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 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 favourite bar stool by hanging his guitar on the wall in the London cafe. Now Hard

< **Global Company Profile**
**Hard Rock Cafe**

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 3500 custom products—in this case, meals—every day. These products are designed, tested, and then analyzed for cost of ingredients, labour 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 textbook, we look not only at how



Andre Jenny/Alamy Stock Photo

Hard Rock Cafe in Orlando, Florida, prepares over 3500 meals each day. Seating more than 1500 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.

Hard Rock's managers create value but also at 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.

## What Is Operations Management?

**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.

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 application 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 a changing global economy. An array of informative examples, charts, text discussions, and pictures illustrate concepts and provide 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** 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 chequing account, the transplant of a human organ, 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*.

# 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).

**(A)**

**Commercial Bank**

**Operations**
Teller scheduling
Cheque clearing
Collection
Transaction processing
Facilities design/layout
Vault operations
Maintenance
Security

**Finance**
Investments
Securities
Real estate

Accounting

Auditing

**Marketing**
Loans
   Commercial
   Industrial
   Financial
   Personal
   Mortgage

Trust department

**(B)**

**Airline**

**Operations**
Ground support equipment
Maintenance
Ground operations
   Facility maintenance
   Catering
Flight operations
   Crew scheduling
   Flying
   Communications
   Dispatching
Management science

**Finance/accounting**
Accounting
   Accounts payable
   Accounts receivable
   General ledger
Finance
   Cash control
   International
      exchange

**Marketing**
Traffic administration
   Reservations
   Schedules
   Tariffs (pricing)
Sales
Advertising

**(C)**

**Manufacturing**

**Operations**
Facilities
   Construction; maintenance
Production and inventory control
   Scheduling; materials control
Quality assurance and control
Supply chain management
Manufacturing
   Tooling; fabrication; assembly
Design
   Product development and design
   Detailed product specifications
Industrial engineering
   Efficient use of machines, space,
   and personnel
Process analysis
   Development and installation of
   production tools and equipment

**Finance/accounting**
Disbursements/credits
   Accounts receivable
   Accounts payable
   General ledger
Funds management
   Money market
   International exchange
Capital requirements
   Stock issue
   Bond issue and recall

**Marketing**
Sales promotion
Advertising
Sales
Market research

**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.

| Farmer | Syrup producer | Bottler | Distributor | Retailer |
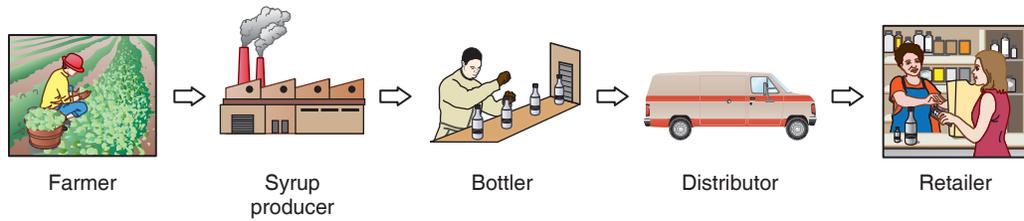
**FIGURE 1.2   Soft Drink Supply Chain**

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.

2. *Production/operations*, which creates, produces, and delivers the product.
3. *Finance/accounting*, which tracks how well the organization is doing, pays the bills, and collects the money.

   Universities, places of worship, and businesses all perform these functions. Even a volunteer group such as Scouts Canada is organized to perform these three basic functions. Figure 1.1 shows how a bank, an airline, and a manufacturing firm organize themselves to perform these functions. The blue-shaded areas of Figure 1.1 show the operations functions in these firms.

## THE SUPPLY CHAIN

**Supply chain**

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

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.

## Why Study Operations Management?

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.

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 its 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 good 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]<br>Increase Sales Revenue 50% | Finance/Accounting Option[b]<br>Reduce Finance Costs 50% | OM Option[c]<br>Reduce Production Costs 20% |
|---|---|---|---|---|
| Sales | $100 000 | $ 150 000 | $100 000 | $100 000 |
| Costs of goods | −80 000 | −120 000 | −80 000 | −64 000 |
| Gross margin | 20 000 | 30 000 | 20 000 | 36 000 |
| Finance costs | −6 000 | −6 000 | −3 000 | −6 000 |
| Subtotal | 14 000 | 24 000 | 17 000 | 30 000 |
| Taxes at 25% | −3 500 | −6 000 | −4 250 | −7 500 |
| Contribution[d] | $ 10 500 | $ 18 000 | $ 12 750 | $ 22 500 |

[a] Increasing sales 50% increases contribution by $7500, or 71% (= 7500/10 500).
[b] Reducing finance costs 50% increases contribution by $2250, or 21% (= 2250/10 500).
[c] Reducing production costs 20% increases contribution by $12 000, or 114% (= 12 000/10 500).
[d] Contribution to fixed costs (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 costs by 50% may both be virtually impossible. Reducing operations costs 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; approximately an 86% increase.]

Example 1 underscores the importance of an 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 major decisions of OM are shown in Table 1.2. Successfully addressing each of these decisions requires planning, organizing, staffing, leading, and controlling. Typical issues relevant to these decisions and the chapter in which each is discussed are also shown.

**Management process**

The application of planning, organizing, staffing, leading, and controlling to the achievement of objectives.

**Table 1.2**
**10 Critical Decisions
of Operations Management**

| 10 Decision Areas | Issues | Chapter(s) |
|---|---|---|
| 1. Design of goods and services | What good or service should we offer? How should we design these products? | 5 |
| 2. Managing quality | How do we define the quality? Who is responsible for quality? | 6, Supplement 6 |
| 3. Process and capacity design | What process and what capacity will these products require? What equipment and technology are necessary for these processes? | 7, Supplement 7 |
| 4. Location strategy | Where should we put the facility? On what criteria should we base the location decision? | 8 |
| 5. Layout strategy | How should we arrange the facility? How large must the facility be to meet our plan? | 9 |
| 6. Human resources and job design | How do we provide a reasonable work environment? How much can we expect our employees to produce? | 10 |
| 7. Supply chain management | Should we make or buy this component? Who should be our suppliers, and how can we integrate them into our strategy? | 11, Supplement 11 |
| 8. Inventory, material requirements planning, and JIT (just-in-time) | How much inventory of each item should we have? When do we reorder? | 12, 14, 16 |
| 9. Intermediate and short-term scheduling | Are we better off keeping people on the payroll during slowdowns? Which job do we perform next? | 13, 15 |
| 10. Maintenance | Who is responsible for maintenance? | 17 |

## WHERE ARE THE OM JOBS?

How does one get started on a career in operations? The 10 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. Competent business students who know their accounting, 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**)
- Standards Council of Canada (**www.scc.ca**)
- Institute for Supply Management (ISM) (**www.instituteforsupplymanagement.org**)
- Project Management Institute (PMI) (**www.pmi.org**)
- Council of Supply Chain Management Professionals (**www.cscmp.org**)

Figure 1.3 shows some possible 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.

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

**Operations Management Positions**

SEARCH JOBS

| Date | Job Title |
|------|-----------|

**1/15** **Plant Manager**
Division of Fortune 1000 company seeks plant manager for plant located in the Vancouver 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.

**2/23** **Operations Analyst**
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, labour 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.

**3/18** **Quality Manager**
Several openings exist in our small package processing facilities in Montreal and Winnipeg 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) process audits to identify areas for improvement, and (3) management of implementation of changes. Positions involve night hours and weekends. Send résumé.

**4/6** **Supply Chain Manager and Planner**
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 two 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. Knowledge of Oracle business systems is a plus. Effective verbal and written communication skills are essential.

**5/14** **Process Improvement Consultants**
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.

**FIGURE 1.3** Many Opportunities Exist for Operations Managers

| Cost Focus | | Quality Focus | Customization Focus |
|------------|--|---------------|---------------------|
| **Early Concepts** **1776–1880** Labour Specialization (Smith, Babbage) Standardized Parts (Whitney) **Scientific Management Era** **1880–1910** Gantt Charts (Gantt) Motion & Time Studies (Gilbreth) Process Analysis (Taylor) Queuing Theory (Erlang) | **Mass Production Era** **1910–1980** Moving Assembly Line (Ford/Sorensen) Statistical Sampling (Shewhart) Economic Order Quantity (Harris) Linear Programming PERT/CPM (DuPont) Material Requirements Planning (MRP) | **Lean Production Era** **1980–1995** Just-in-Time (JIT) Computer-Aided Design (CAD) Electronic Data Interchange (EDI) Total Quality Management (TQM) Baldrige Award Empowerment Kanbans | **Mass Customization Era** **1995–2015** Globalization Internet/Ecommerce Enterprise Resource Planning International Quality Standards (ISO) Finite Scheduling Supply Chain Management Mass Customization Build-to-Order Sustainability |

**FIGURE 1.4** Significant Events in Operations Management

Everett Collection/Newscom
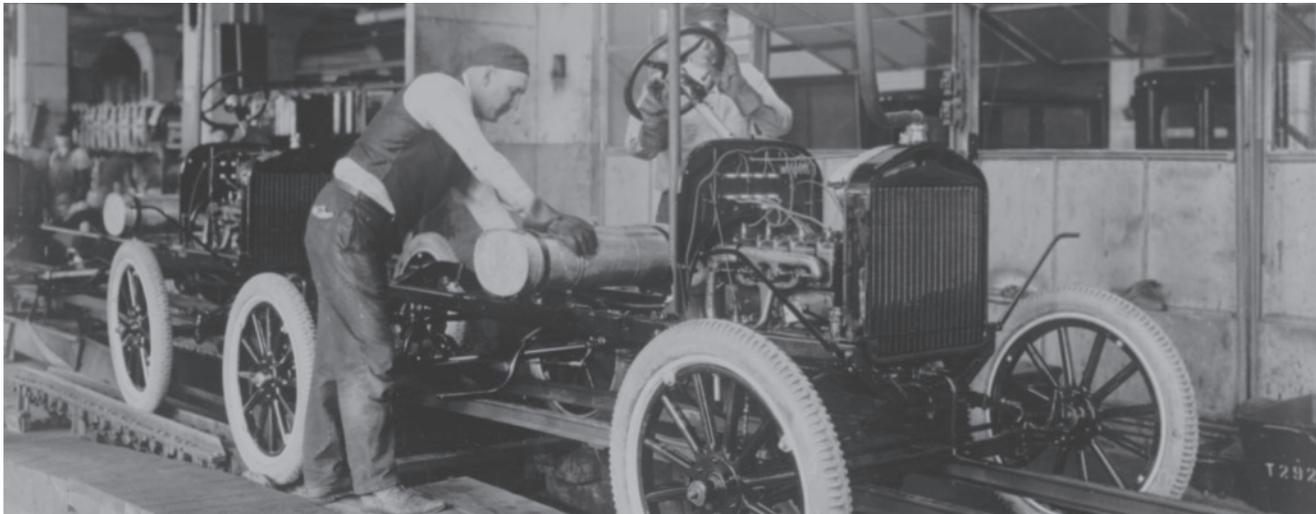
U.S. government for 10 000 muskets, he was able to command a premium price because of their interchangeable parts.

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.

By 1913, Henry Ford and Charles Sorensen combined what they knew about standardized parts with the quasi-assembly lines of the meatpacking and mail-order industries and added the revolutionary concept of the assembly line, where men stood still and material moved.

Quality control is another historically significant contribution to the field of OM. Walter Shewhart (1924) combined his knowledge of statistics with the need for quality control and provided the foundations for statistical sampling in quality control. W. Edwards Deming (1950) believed, as did Frederick Taylor, that management must do more to improve the work environment and processes so that quality can be improved.

Operations management will continue to progress with contributions from other disciplines, including *industrial engineering* and *management science*. These disciplines, along with statistics, management, and economics, contribute to improved models and decision making.

Innovations from the *physical sciences* (biology, anatomy, chemistry, and physics) have also contributed to advances in OM. These innovations include new adhesives, faster integrated circuits, gamma rays to sanitize food products, and higher-quality glass for LCD and plasma TVs. Innovation in products and processes often depends on advances in the physical sciences.

Especially important contributions to OM have come from *information technology*, which we define as the systematic processing of data to yield information. Information technology—with wireless links, internet, and ecommerce—is reducing costs and accelerating communication.

Decisions in operations management require individuals who are well versed in management science, in information technology, and often in one of the biological or physical sciences. In this textbook, we look at the diverse ways a student can prepare for a career in operations management.

# Operations in the Service Sector

Manufacturers produce a tangible product, while service products are often intangible. But many products are a combination of a good and a service, which complicates the definition of a service. Even the Canadian government has trouble generating a consistent definition. Because definitions vary, much of the data and statistics generated about the service sector are inconsistent. However, we define **services** as including repair and maintenance, government, food and lodging, transportation, insurance, trade, financial, real estate, education, law, medicine, entertainment, and other professional occupations.

**Services**
Economic activities that typically produce an intangible product (such as education, entertainment, lodging, government, financial, and health services).

## DIFFERENCES BETWEEN GOODS AND SERVICES

Let's examine some of the differences between goods and services:

**LO2** Explain the distinction between goods and services

- Services are usually *intangible* (for example, your purchase of a ride in an empty airline seat between two cities) as opposed to a tangible good.
- Services are often *produced and consumed simultaneously*; there is no stored inventory. For instance, the beauty salon produces a haircut that is "consumed" simultaneously, or the doctor produces an operation that is "consumed" as it is produced. We have not yet figured out how to inventory haircuts or appendectomies.
- Services are often *unique*. Your mix of financial coverage, such as investments and insurance policies, may not be the same as anyone else's, just as the medical procedure or a haircut produced for you is not exactly like anyone else's.
- Services have *high customer interaction*. Services are often difficult to standardize, automate, and make as efficient as we would like because customer interaction demands uniqueness. In fact, in many cases this uniqueness is what the customer is paying for; therefore, the operations manager must ensure that the product is designed (i.e., customized) so that it can be delivered in the required unique manner.
- Services have *inconsistent product definition*. Product definition may be rigorous, as in the case of an auto insurance policy, but inconsistent because policyholders change cars and policies mature.
- Services are often *knowledge based*, as in the case of educational, medical, and legal services, and therefore hard to automate.
- Services are frequently *dispersed*. Dispersion occurs because services are frequently brought to the client/customer via a local office, a retail outlet, or even a house call.

The activities of the operations function are often very similar for both goods and services. For instance, both goods and services must have quality standards established, and both must be designed and processed on a schedule in a facility where human resources are employed.

Having made the distinction between goods and services, we should point out that, in many cases, the distinction is not clear-cut. In reality, almost all services and almost all goods are a mixture of a service and a tangible product. Even services such as consulting may require a tangible report. Similarly, the sale of most goods includes a service. For instance, many products have the service components of financing and delivery (e.g., automobile sales). Many also require after-sale training and maintenance (e.g., office copiers and machinery). "Service" activities may also be an integral part of production. Human resource activities, logistics, accounting, training, field service, and repair are all service activities, but they take place within a manufacturing organization. Very few services are "pure," meaning they have no tangible component. Counselling may be one of the exceptions.

## GROWTH OF SERVICES

Services constitute the largest economic sector in postindustrial societies. Until about 1900, many Canadians were employed in agriculture. Increased agricultural productivity allowed people to leave the farm and seek employment in the city. Similarly, manufacturing employment has decreased in North America in the past 30 years. The Canadian market tends to follow U.S. trends, as can be seen in the following comparison. The changes in U.S. agriculture, manufacturing, and service employment are shown in Figure 1.5. Although the number of people employed in manufacturing has decreased since 1950, each person is now producing almost 20 times more than in 1950. Services became the dominant employer in the early 1920s, with manufacturing employment peaking at about 32% in 1950. The huge productivity increases in