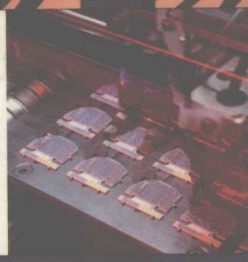
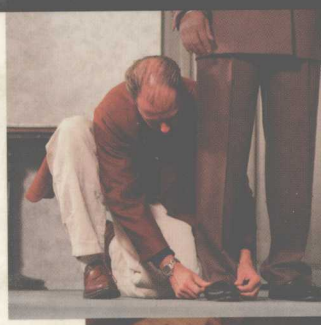
SIXTH EDITION

# PRODUCTION OPERATIONS MANAGEMENT







WILLIAM J. STEVENSON

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# PRODUCTION/OPERATIONS MANAGEMENT

**SIXTH EDITION**

**WILLIAM J. STEVENSON**
*Rochester Institute of Technology*

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# PREFACE

The material in this book is intended as an introduction to the field of production and operations management. It is suitable for both undergraduate and graduate students. The field of production and operations management is dynamic, and very much a part of many of the good things that are happening in business organizations. The book is intended to be interesting and informative. Much of what you learn will have practical application.

The subject matter represents a blend of concepts from industrial engineering, cost accounting, general management, quantitative methods, and statistics. Production and operations activities, such as forecasting, choosing a location for an office or plant, allocating resources, designing products and services, scheduling activities, and assuring and improving quality are core activities and often strategic issues in business organizations. Some of you are or will be employed directly in these areas, while others will have jobs that are indirectly related to this area. So whether this is your field of study or not, knowledge of this field will certainly benefit you and the organization you work for.

The text contains more material than one could normally hope to cover in a one-semester course. Rather than rely on the author's personal bias, each instructor can choose those topics most suited to his or her own proclivities. Those who prefer an analytic quantitative emphasis, for example, will be quite comfortable with the abundance of examples and student problems. Those who prefer a more qualitative approach will welcome the fact that some of the more quantitative material is placed in chapter supplements and that there are memo exercises, operations tours, and cases for assignment. Obviously, there are many possibilities between these two extremes.

## ACKNOWLEDGMENTS

I would like to thank the reviewers of this edition who contributed significantly to the final product. They are: W. C. Benton, Ohio State University; Roy Boykin, California State University–Chico; Renato de Matta, University of Iowa; Ed Duplaga, Bowling Green State University; Frank Forst, Loyola University; Mark Gershon, Temple University; Nicholas A. Glaskowsky, University of Miami; Lisa Houts, California State University–Fresno; Tim Ireland, Oklahoma State University; Tom Johnson, University of South Florida; Xenophone Koufteras, University of Texas–El Paso; Arundhati Kumar, California State University–Northridge; Satish Mehra, University of Memphis; Mike Pesch, St. Cloud State University; Gregory J. Petrakis, Ottawa University and University of Missouri; Jeff Rummel, University of Connecticut; Buddhadev Roychoudhury, Mankato State University; Leonard Ross, California State Polytechnic University; Harold Schramm, University of Dubuque; and Victor Sower, Sam Houston State University.

I would also like to thank all of the reviewers of previous editions for their valuable contributions to the success of this book.

Many students and instructors offered valuable suggestions, and I want to thank them as well. And, Lee Tangedahl, Renato de Matta, and Frank Forst did a superb job of accuracy checking.

I would also like to thank the authors of the various CD-ROM supplements and stand-alone supplements that are designed to accompany the textbook. Lee Tangedahl developed the spreadsheet templates; Mehdi Kaighobadi put together the data files; Ceyhun Ozgur updated the Instructor's Manual; Ralph Butler developed Powerpoint presentations; Seung Lae Kim updated the Test Bank and the CompuTest; and Paul Van Ness coauthored the Study Guide.

Finally, I want to extend my thanks to all of the people at Irwin/McGraw-Hill for their efforts and support. It is always a pleasure to work with such a competent and professional group of people. Special thank you's go to Dick Hercher, Wanda Zeman, and Jean Lou Hess.

**William J. Stevenson**

# NOTE TO THE STUDENT

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

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

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

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

1. *Identify the key features* of that material.
2. *Define and use terminology.*
3. *Solve typical problems.*
4. *Recognize applications* of the concepts and techniques covered.
5. *Discuss the subject matter* in some depth, including its relevance, managerial considerations, and advantages and limitations.

You will encounter a number of chapter supplements. Check with your instructor to determine whether or not to study them.

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

I suggest the following approach for studying and problem solving:

1. Look over the chapter outline and learning objectives.
2. Read the chapter summary, and then skim the chapter.
3. Read the chapter and take notes using the study questions on the CD-ROM.
4. Look over and try to answer the discussion and review questions.
5. Solve the problems, referring to the solved problems and chapter examples as needed.

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

A study guide is also available. If your bookstore does not stock it, you can ask them to order it for you.

Enjoy!

**W.J.S.**

*This Book Is Dedicated to You*

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PRODUCTION/OPERATIONS MANAGEMENT



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# BRIEF CONTENTS

# CONTENTS

# PART ONE
# INTRODUCTION

Introduction to production/ operations management includes two chapters:

1. Production and operations management, Chapter 1
2. Productivity, competitiveness, and strategy, Chapter 2

Chapter 1 introduces you to the field of operations management. It describes the nature and scope of operations management, and how operations management relates to other parts of the organization. Among the important topics it covers are the different types of production systems, a comparison of manufacturing and service operations, a brief history of operations management, and a list of recent trends in operations. After you have read this chapter, you will have a good understanding of what the operations function of a business organization encompasses.

Chapter 2 discusses operations management in a broader context, and presents the issues of productivity, competition, and strategy. After you have read Chapter 2, you will understand the importance of the operations function relative to the goals of a business organization. This chapter also describes time-based strategies, which many organizations are now adopting as they seek to become more competitive and to better serve their customers. The supplement of Chapter 2 describes *decision theory*.


"If it ain't broke, keep looking."
BELL ATLANTIC WAY BEHAVIORS
COACH

## LEARNING OBJECTIVES

*After completing this chapter, you should be able to:*

1. Define the term *production/operations management* (POM).
2. Identify the three major functional areas of organizations and describe how they interrelate.
3. Describe the operations function and the nature of the operations manager's job.
4. Differentiate between design and operation of production systems.
5. Provide a general description of the different types of operations.
6. Compare and contrast service and manufacturing operations.
7. Briefly describe the historical evolution of POM.
8. Describe the key aspects of operations management decision making.
9. Identify some of the current trends in operations management.
10. Describe the *Pareto phenomenon* and tell why it is important in problem solving.

# CHAPTER ONE
# PRODUCTION AND OPERATIONS MANAGEMENT

## CHAPTER OUTLINE

This book is about production and operations management (POM), which involves the planning, coordinating, and executing of all activities that create goods or provide services. The subject matter is fascinating and timely: productivity, quality, foreign competition, and customer service are very much in the news. All are part of production and operations management. This first chapter presents an introduction and overview of operations management. Among the issues it addresses are: What is operations management? Why is it important? What does an operations manager do?

The chapter also provides a brief description of the historical evolution of operations management, and a discussion of the current trends that impact operations management.

## INTRODUCTION

To many people, the term *production* conjures up images of factories, machines, and assembly lines. Interestingly enough, the field of production management in the past focused almost exclusively on manufacturing management, with a heavy emphasis on the methods and techniques used in operating a factory. In recent years, the scope of production management has broadened considerably. Production concepts and techniques are applied to a wide range of activities and situations *outside* manufacturing; that is, in *services* such as health care, food service, recreation, banking, hotel management, retail sales, education, transportation, and government. This broadened scope has given the field the name *production/operations management*, or more simply, **operations management,** a term that more closely reflects the diverse nature of activities to which its concepts and techniques are applied.

**operations management**
The management of systems or processes that *create goods and/or provide services.*

We can use an airline company to illustrate a production/operations system. The system consists of the airplanes, airport facilities, and maintenance facilities, sometimes spread out over a wide territory. Most of the activities performed by management and employees fall into the realm of operations management:

*Forecasting* such things as weather and landing conditions, seat demand for flights, and the growth in air travel.

*Capacity planning,* essential for the airline to maintain the cash flow and make a reasonable profit. (Too few or too many planes, or even the right number of planes but in the wrong places, will hurt profits.)

*Southwest Airlines workers at the maintenance hangar in Dallas performing a routine maintenance check on a Boeing 737 engine. Checks are periodically performed based on a maintenance schedule guided by FAA regulations.*

www.iflyswa.com

*Scheduling* of planes for flights and for routine maintenance; scheduling of pilots and flight attendants; and scheduling of ground crews, counter staff, and baggage handlers.

*Managing inventory* of such items as foods and beverages, first-aid equipment, in-flight magazines, pillows and blankets, life preservers.

*Assuring quality,* essential in flying and maintenance operations, where the emphasis is on safety. Also important in dealing with customers at ticket counters, check-in, telephone reservations, and curb service, where the emphasis is on efficiency and courtesy.

*Employee motivation and training* in all phases of operations.

*Location of facilities* according to managers' decisions on which cities to provide service for, where to locate maintenance facilities, and where to locate major and minor hubs.

Now consider a bicycle factory. This might be primarily an *assembly* operation: buying components such as frames, tires, wheels, gears, and other items from suppliers, and then assembling bicycles. The factory might also do some of the *fabrication* work itself, forming frames, making the gears and chains, and buy mainly raw materials and a few parts and materials such as paint, nuts and bolts, and tires. Among the key management tasks in either case are scheduling production, deciding which components to make and which to buy, ordering parts and materials, deciding on the style of bicycle to produce and how many, purchasing new equipment to replace old or worn out equipment, maintaining equipment, motivating workers, and ensuring that quality standards are met.

Obviously, an airline company and a bicycle factory are completely different types of operations. One is primarily a service operation, the other a producer of goods. Nonetheless, these two operations have much in common. Both involve scheduling of activities, motivating employees, ordering and managing supplies, selecting and maintaining equipment, satisfying quality standards, and—above all—satisfying customers. In both systems, the success of the business depends on short- and long-term planning.

## WHY STUDY OPERATIONS MANAGEMENT?

You may be wondering why you need to study operations management. Actually, there are a number of very good reasons. One is that operations management activities are at the core of *all* business organizations, regardless of what business they are in. Second, 35 percent or more of all jobs are in operations management-related areas—such areas as customer service, quality assurance, production planning and control, scheduling, job design, inventory management, and many more. Third, activities in all of the other areas of business organizations, such as finance, accounting, human resources, logistics, marketing, purchasing, as well as others are all interrelated with operations management activities, so it is essential for these people to have a basic understanding of operations management. But beyond all of this is the reality that production/operations management is about *management,* and *all managers* need to possess the knowledge and skills in the content areas you will learn about here. Among them are productivity, strategy, forecasting, quality, inventory control, and scheduling. Also, you will learn how to use a range of quantitative tools that enhance managerial decision making.

If you are thinking of a career in production/operations management, you can benefit by joining one or more of the professional societies.

American Production and Inventory Control Society (APICS)
500 West Annandale Road, Falls Church, Virginia 22046-4274
www.apics-stlouis.com/
www.apics-houston.org/
www.apicsaustin.com/

American Society for Quality (ASQ)
230 West Wells Street, Milwaukee, Wisconsin 53203

National Association of Purchasing Management (NAPM)
2055 E. Centennial Circle, Tempe, AZ 85284
www.napm.org

Association for Systems Management
P.O. Box 38370, Cleveland, Ohio 44130-0307
www.infoanalytic.com/asm/

APICS and NAPM both offer a practitioner certification examination that can enhance your qualifications. Information about job opportunities can be obtained from all of these societies as well as from other sources, such as the Decision Sciences Institute (University Plaza, Atlanta, Georgia, 30303), and the Institute of Industrial Engineers (25 Technology Park, Norcross, Georgia, 30092).

## FUNCTIONS WITHIN BUSINESS ORGANIZATIONS

Organizations are formed to pursue goals that are achieved more efficiently by the concerted efforts of a group of people than by individuals working alone. Business organizations are devoted to producing goods and/or providing services. They may be for-profit or nonprofit organizations. Their goals, products, and services may be similar or quite different. Nonetheless, their functions and the way they operate are similar.

A typical business organization has three basic functions: finance, marketing, and production/operations (see Figure 1–1). These three functions, and other supporting functions, perform different but *related* activities necessary for the operation of the organization. The interdependency of the major functions is depicted by overlapping circles in Figure 1–2. The functions must interact to achieve the goals and objectives of the organization, and each makes an important contribution. Often the success of an organization depends not only on how well each area performs but also on how well the areas *interface* with each other. For instance, unless production and marketing work together, marketing may promote goods or services that production cannot profitably deliver, or production may turn out goods or services for which there is no demand. Similarly, unless finance and production people work closely, funds for expansion or new equipment may not be available when needed.

Let's take a closer look at these functions.

### Operations

The operational function consists of all activities *directly* related to producing goods or providing services. The production function exists not only in manufacturing and as-

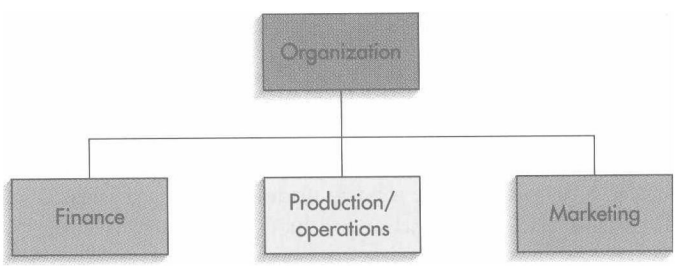


**FIGURE 1–1**
*The three basic functions of business organizations*

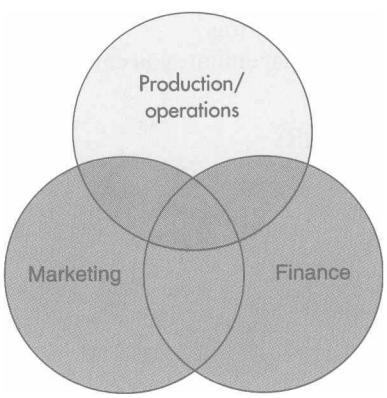


**FIGURE 1–2**
*The three major functions of business organizations overlap*