

Operations Management/Theory and Problems

Second
Edition

Joseph G. Monks





OPERATIONS MANAGEMENT Theory and Problems

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Gonzaga University

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OPERATIONS MANAGEMENT: Theory and Problems

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Preface

This book covers material professionally recognized as belonging to the field of production and operations management. It is based on the concept that managers are decision makers and that the ability to make better managerial decisions is something that can be learned. The operations we speak of involve industrial plants and service activities such as hospitals, airlines, and government agencies. They all face common theoretical problems in systems design, resource allocation, work scheduling, and inventory and quality control.

The text is intended for a first course in production or operations management at the undergraduate or graduate level. It presents the theory and applications of operations management in a framework that is particularly suitable for student learning, with the ultimate goal of developing better decision-making skills. Statements of theory are intentionally basic, concise, and even simple. Because I am convinced that applications and skill-building exercises are the key to driving home important concepts, there are over 200 examples and solved problems and over 250 problems to solve. To facilitate self-learning on the part of the student, special effort has been made to illustrate problem solutions in a clear and logical manner.

As human beings we are most fulfilled by the acquisition of knowledge and/or skills which, when combined with values, facilitate rational, humane decisions. Decision making thus merges facts, concepts, and methodologies with an understanding and appreciation of human value systems. The result is informed judgment.

We shall not attempt to cover every remotely related principle of knowledge in this book, nor shall we demand a reorientation of the reader's own value system. But we shall focus on fundamentally important concepts, practice relevant problem-solving skills, and make an effort to instill an awareness of the role of values in the decision-making process. Contrary to the beliefs of many traditional approaches to education, business decisions are not value-free. It is time that we, as educators, recognize this.

Operations management courses have gradually incorporated an increasing amount of quantitative methodology because quantitative techniques improve management's decision-making ability. In some cases, however, theory has far outpaced practice. This text concentrates on theory that has the potential of application in a meaningful way. It does make frequent use of the mathematical and statistical preparation normally acquired at the freshman and sophomore collegiate levels. However, years in the classroom have convinced me that students occasionally "forget" their statistics. Thus, the necessary concepts are reviewed herein as we progress. Quantitative methodologies are introduced in an applications context when first appropriate rather than concentrated at the start of the text or isolated in an appendix.

The material throughout the text is integrated within the structure of a conceptual model developed in the first chapter. Nevertheless, the topics are packaged to allow maximum discretion over coverage on the part of the instructor. Most chapters are individual units of study and can be handled in a different order from that presented here, or a chapter can be bypassed without significant loss of continuity. The production and inventory control material in Chapters 8 to 12 does, however, constitute a package that should be fully covered by those students planning to take the professional certification examinations offered by the American Production and Inventory Control Society (APICS). The maintenance and cost control topics in Chapter 15 can be handled independently without jeopardizing coverage of other material in the chapter.

In a sense, the book is somewhat akin to a reference manual in that the relatively brief text materials are followed by solved problems that solidify operations management concepts and illustrate how the theory is applied in a decision-making context. The problems can be included or omitted, depending on the time available and the emphasis placed on the chapter by the instructor. Each solved problem emphasizes a slightly different perspective or a more advanced aspect of the theory. There are also a few starred (*) problems which offer a challenge of extending beyond the basic material that lies in the body of the chapters. These problems should be considered optional. The examples and solved problems are often helpful to the solution of unsolved problems at the end of the chapters. Answers to the odd-numbered problems are given in Appendix A.

Users of the first edition will note the expanded coverage of production and inventory control and a more extensive integration of service industry applications throughout the text. This edition also makes wider use of graphics and flow charts. Treatment of linear programming and PERT is enhanced, and simulation concepts are integrated in several chapters. A more subtle, but important, structural addition is the organizational framework provided by the concepts of priority and capacity. These concepts are introduced early in the text and are well ingrained by the time the reader gets to MRP and CRP. Since they are such strong and (obviously) unifying concepts, it is surprising that texts—including the first edition of this one—have not picked up on this sooner.

This edition also introduces a study guide (optional) which has been in preparation for several years. It focuses on key terms and the more difficult concepts, and it includes exercises which may be used in the classroom or for independent study.

Finally, a note of appreciation to the individuals and organizations who helped in one way or another to produce this book. First, I wish to thank my students at Oregon State and Gonzaga Universities for their constructive criticism of the preliminary drafts of the manuscript. I am appreciative of the first-edition encouragement and support received from Art Stonehill and Cliff Gray of Oregon State University; Professor David O'Mahony, of University College Cork (Ireland); and faculty members at the Manchester Business School (England). Oliver Wight and Walt Goddard, of Oliver Wight, Inc.; Harlow Loucks, of Tektronix; and other professionals in the American Production and Inventory Control Society (APICS) have profoundly influenced my thinking. I personally feel APICS is one of the most useful and effective societies in the world, and I strongly encourage students interested in operations management to become affiliated with it early and to participate actively.

A special thanks goes to Gonzaga University President Bernard J. Coughlin, S.J., Dean Clarence Barnes, and colleagues Dan Brajcich, Doug Mallenby, and Dr. Erwin Graue, and to Kinsey Robinson, Luke Williams, and numerous others of the Spokane business community. Each contributed in a unique way to the book. Terry Coombes made a vital contribution by managing my time and arranging for whatever assistance was needed. And typing was admirably done by Pat Bryant, Nancy Safford, Karen McMaster, Nancy Wright, and Sara Gilmore.

I am particularly indebted to my reviewers for an outstanding job and some extremely useful comments. These were Joseph Blackburn, Vanderbilt University; Dick Dailey, Washington State University; Richard Discenza, Northern Arizona University; Steve Goodman, Florida State University; Fred Luthans, University of Nebraska; Joseph Milutinovich, Temple University; Richard Newman, Indiana University–Northwest; Robert Roeloffs, Shippensburg State College; and Edward Stafford, University of South Carolina. To these, to my wife Clara, and to countless others who contributed, thanks.

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Chapter 2 Operations Decision Making

Chapter 3 Facility Location and Layout

Chapter 4 Capital Inputs

Chapter 5 Materials Management

Chapter 6 Human Resource Inputs

Chapter 7 Product and Process Planning and Analysis

PREVIEW: SYSTEM DESIGN AND PLANNING ACTIVITIES

Productive systems transform input resources into higher-valued outputs. The inputs are typically classified as human, material, and capital. Outputs range from assembled products like automobiles to all manner of services, such as medical and educational services.

In this section we study system design and planning activities for producing goods and services. Figure I-1 illustrates two simplified production systems. Both have many of the same managerial problems and opportunities. But services usually give the consumer an immediate benefit, whereas goods store the benefits until the consumer is ready to use them. Thus services are less “inventory”-oriented. Nevertheless, both types of systems use human, material, and capital resources to develop higher-valued outputs.

Our study of system design and planning activities will encompass the following topics.

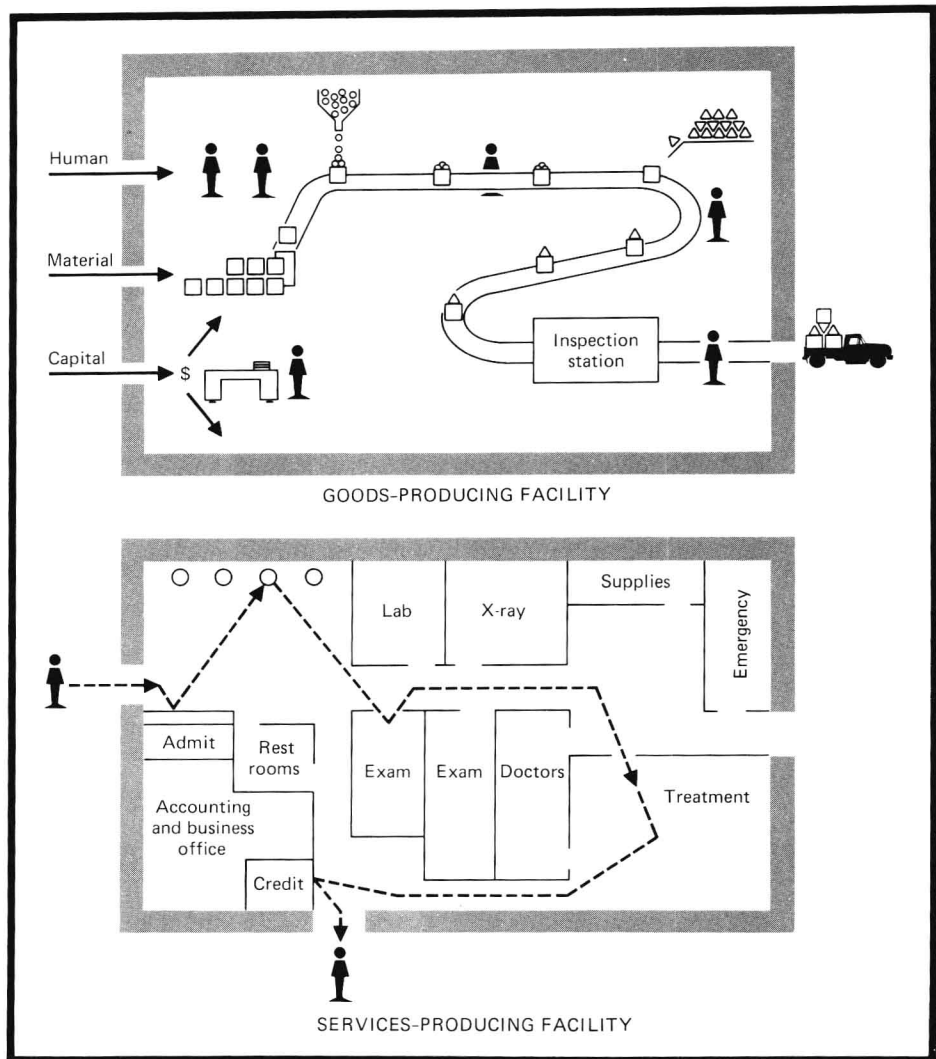


FIGURE I-1 Goods- and Services-Producing Facilities

OPERATIONS MANAGEMENT CONCEPTS (Chapter 1)

We begin with some historical background and a definition of operations management. Chapter 1 is brief, but it contains some essential fundamentals of the role of management.

OPERATIONS DECISION MAKING (Chapter 2)

Decision concepts are studied next because decision making is one of the prime functions of a manager. Potential managers can sharpen their decision-making skills by using systematic procedures and employing proven analytical techniques. This chapter outlines a framework for decision making and reviews some methodology that is especially appropriate for the management of operations.

FACILITY LOCATION AND LAYOUT (Chapter 3)

Facility location and layout is an early and significant concern because it usually entails a large investment of capital. Facility decisions require careful analysis of both economic and environmental effects. This chapter offers some guidelines for making location and capacity decisions and describes alternative ways of laying out facilities for the production of goods and services.

CAPITAL INPUTS (Chapter 4)

This chapter and the next two chapters discuss the three major inputs to the production process: capital, material, and labor. Chapter 4 focuses upon the significance of capital inputs.

Capital is needed for expanding facilities, buying new equipment, and financing assets, such as inventories. Many of the capital decisions commit the organization to long-run costs, so they deserve careful evaluation. This chapter offers some effective ways of making the best use of available capital.

MATERIALS MANAGEMENT (Chapter 5)

The mounting scarcity and cost of material resources have propelled materials management into an increasingly critical role. Chapter 5 discusses key aspects of materials management, from the initial purchasing activities to the final shipment of finished goods.

HUMAN RESOURCE INPUTS (Chapter 6)

Human resources are the most intrinsically valuable assets of any organization. Being both physically and psychologically sensitive, people require special consideration. They cannot be treated like machines, even though their (variable-paced) activities must often be interfaced with the work of (fixed-pace) machines. This chapter offers some principles for managing the human resources of an organization and describes some techniques for developing standards of performance for workers.

PRODUCT AND PROCESS PLANNING AND ANALYSIS (Chapter 7)

Chapter 7 describes how inputs are integrated into a process for delivering goods or services. It includes consideration of research and development activities, product and process planning, and product selection. Some methods for analyzing and evaluating production processes are also included.

Part II of the text will carry forward with more detail on the production and inventory control activities. But first we must build a foundation from the material contained in Part I.

As you take up each topic in Part I, read the chapter through in quick fashion to grasp the organization and major ideas. Don't try to pick up every detail at this stage. Save the intensive study for a second reading, wherein you spend enough time to gain a thorough understanding of the content, including examples and solved problems. You'll find that most theory sections and examples bring out only one (or perhaps two) methodological points. So after you have waded through a section or an example, take an extra moment to get the full benefit from your study. Use it to crystallize the main idea or to identify that critical step in a problem which really turned on the light of a solution. The few moments you spend abstracting key concepts can be as valuable as many hours of reading and working out problems.

Operations Management Concepts

HISTORICAL DEVELOPMENT

Factory System Beginnings
Effect of the Civil War
Scientific Management Era
Operations Research and Computers

DEFINITION OF OPERATIONS MANAGEMENT

Resources
Systems: Design and Control
Transformation and Value-Adding
Activities
Managerial Policy

THE ENVIRONMENT OF OPERATIONS

DECISION-MAKING RESPONSIBILITY AREAS

SUMMARY

QUESTIONS

BIBLIOGRAPHY

Two hundred years ago, the field of operations management did not exist. If you had been fortunate enough to be enrolled in a university just after the Revolutionary War, you would not have had the opportunity (or perhaps you prefer the words “have been required”) to learn the type of material that lies ahead in this text. Compared to some arts and sciences, operations management is a newcomer, born of an industrial and managerial revolution and nurtured by scientific inquiry and technological innovation.

The term “operations management” has come into popular use only during the past several years. It has evolved from factory-oriented terms like “manufacturing management” and “production operations,” but it conveys a broader meaning which now fully embraces service industries and nonprofit activities as well.

This expanded scope of operations is appropriate because services now account for about 60 percent of our nation’s productive output [11]. Furthermore, the underlying theory of operations management is common to both goods and services. Forecasting, scheduling, quality control, and other managerial activities

have much in common from one type of operation to the next. Thus most of the material you are about to study is as applicable to the management of hospital or airline operations as it is to the manufacture of automobiles.

Our objective lies in developing a comprehensive theoretical framework for managing the wide range of productive operations that sustain and enhance our society. But theory without practice is empty, so we shall be careful to develop the corresponding skill of application with frequent illustrations and example problems. Problems are like miniature cases. They will help build your confidence in facing future managerial decisions.

Our interest lies primarily with the analysis and methodology of solution—not necessarily with grinding out the numbers of a solution. That can often be done on a computer. Further, we must be alert to qualitative as well as quantitative dimensions in our analysis. Real world problems rarely come in segregated packages.

In this first chapter you will develop an understanding of operations management that will serve you throughout the remainder of the text. After a brief look at some historical background, operations management is defined, and the definition is explained in terms of a schematic model. Then the influence of the social and economic environment upon productive operations is recognized. The chapter ends with an identification of the types of decisions that confront operations managers; these types are related to the model.

This chapter establishes the structure for the theory and applications that follow, so you will want to gain a clear understanding of it. With close attention to the terms and definitions, you will be well prepared to apply them in later chapters of the text. For example, once you understand the concept of control, it is a short step to extend it to inventory control, quality control, and cost control.

With this brief introduction, let us set the stage by tracing the major events which have influenced the development of operations management.

HISTORICAL DEVELOPMENT

Productive endeavors date back to the Egyptian pyramids (2500 B.C.), the Great Wall of China (200 B.C.), and the aqueducts, roads, and baths constructed by the Romans at the time of Christ. However, the production of goods was at a handcraft level until the Industrial Revolution took hold in the early 1800s. Figure 1-1 depicts some of the key individuals and events that contributed to the development of modern production operations.

FACTORY SYSTEM BEGINNINGS

Some settlers came to America as participants in business ventures as early as 1609. Unfortunately, the ventures were an economic disaster. As colonization

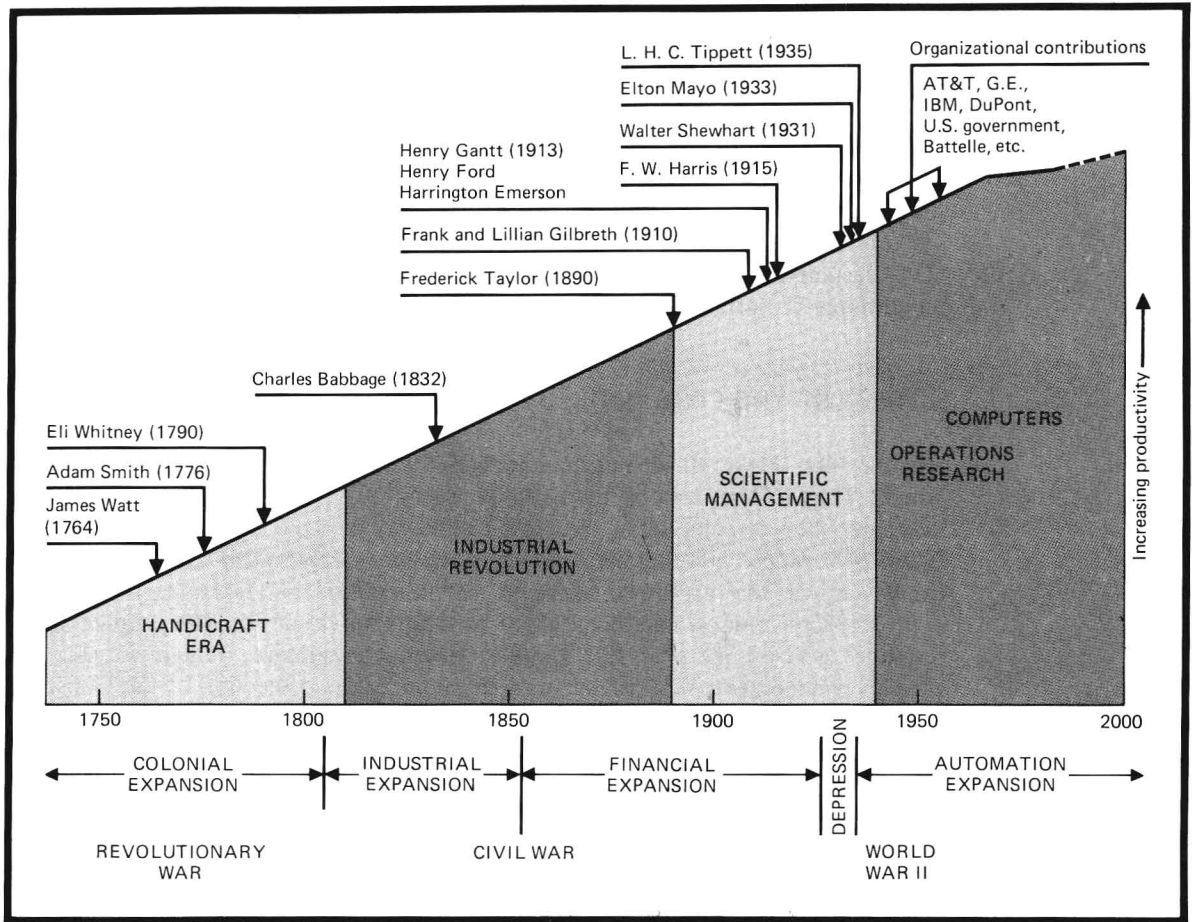


FIGURE 1-1 Key Individuals and Events in the Development of Production Systems

continued, merchants such as John Hancock and Thomas Jefferson developed trade which depended upon England for imports. But the colonists objected to paying high taxes to England. The events of 1776 were a turning point, when trade reform became political reform. Three noteworthy events occurred within the span of a few years:

- 1 James Watt's steam engine (1764) opened the door to using mechanical power to increase productivity.
- 2 The Revolutionary War (1776) and resulting Constitution (1789) encouraged capital investment and trade by protecting private property and contract rights.
- 3 Adam Smith's *Wealth of Nations* (1776) publicized the advantages of the division of labor, which included skill development, time savings, and the use of specialized machines.