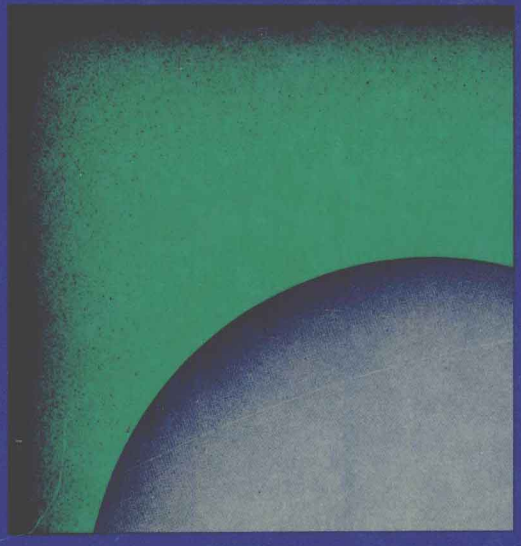
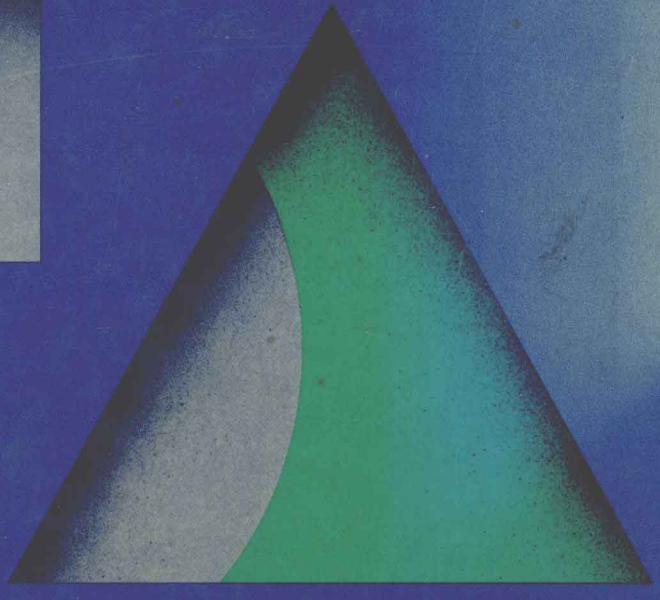
Modern Production/ Operations Management

Eighth Edition





Elwood S. Buffa
Rakesh K. Sarin

MODERN PRODUCTION/ OPERATIONS MANAGEMENT

EIGHTH EDITION

ELWOOD S. BUFFA

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UNIVERSITY OF CALIFORNIA, LOS ANGELES

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Elwood S. Buffa is the Times Mirror Professor at the UCLA Graduate School of Management. His most recent books are, *Meeting the Competitive Challenge: Manufacturing Strategy for U.S. Companies,* Dow Jones–Irwin, Inc., 1984, and, *Corporate Strategic Analysis* (coauthored with Marc Bogue), The Free Press, 1986. He has published many other books and articles in production and manufacturing and management science that deal with both strategic and operations problems. He has engaged in consulting activities in a wide variety of settings during the past twenty-five years, and serves on the board of directors of Planmetrics, Inc. Buffa received his B.S. and MBA degrees from the University of Wisconsin, and his Ph.D. in engineering from the University of California, Los Angeles.

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To Betty, Chachi, and Anna

PREFACE

The decline of the competitive position of U.S. manufactured products in global markets has focused new attention on production and operations management, both in course work in colleges and universities and in business enterprises. The President's Commission on Industrial Competitiveness devoted a great deal of their final report to the issues of productivity, quality, and process technology and their importance in building and maintaining a national competitive position. These are issues that are at the core of production and operations management, and the commission's report provides new and important reasons why every student of management and business administration should have a basic understanding of the field.

The eighth edition marks a major revision of *Modern Production/Operations Management.* In addition, Rakesh Sarin joins as coauthor, providing a fresh approach to the scope and organization of the book as well as to many individual topics. The eighth edition focuses on a simpler but more quantitative step-by-step development. It begins with relatively simple, well-defined subject matter in operations planning and control, such as forecasting and inventory planning and control. Modular information is cumulated toward more complex materials that deal with system design and, finally, the strategic implications of operations.

The opening major section initially deals with the role of operations systems in profitability and competitiveness. How can the operations function make a difference in the ability of an enterprise to compete and survive? Then, types and characteristics of operations systems are discussed in two chapters, one for manufacturing systems and a second for service systems. These chapters are very important in providing initial scope and definition to the course.

The second major section focuses on operations planning and control providing basic knowledge about operations problems that will be valuable in building the students' knowledge base in operations management. In this section, a set of conceptual and analytical tools are presented that are useful in analyzing some well-defined, common, operations management problems. The emphasis is on basic models that capture the key trade-offs involved in the decision. A guide to more advanced materials is provided where appropriate. Chapters dealing with methodology such as linear programming and simulation, are inserted in the sequence needed to deal with chapters on specific operations problems. These methodology chapters

may be skipped by instructors whose course has a prerequisite course in management science/operations research.

In keeping with a new emphasis on quality in U.S. manufacturing, two chapters are devoted to this important area, the first dealing broadly with quality assurance and the second devoted to a rather complete coverage of statistical quality control methodology. A full chapter is devoted to Japanese manufacturing systems, reflecting the high interest in these unique methods.

The third major section deals with the design of systems. A special new chapter deals with product–process design, with attention given to the advanced technologies of numerical control, CAD/CAM, robotics, FMS, and the like. The system design section continues with individual chapters on capacity planning, location and distribution, job design, and, finally, facility layout as an expression of the resulting design. Embedded in the sequence is a special chapter on waiting line models, providing an analytical base for the design of service systems, and because most productive system designs must be appraised by more than one criterion, Chapter 21 provides a methodological overview of multicriteria decisions.

Finally, the new emphasis on the role of operations strategy in corporate strategy is reflected in two chapters, the first dealing with a framework for operations strategy formulation and the second dealing with implementation. The final chapter looks to operations systems of the future within the context of the past.

At the end of each chapter there are review questions, and problems and situations (short cases) where appropriate. There are a large number of problems in appropriate chapters arranged with increasing complexity.

Major Changes in the Eighth Edition

The eighth edition represents several additions and major revisions in almost all the chapters of the previous edition. In terms of new and old materials, most of the materials in the three chapters of Part One are new. The ten chapters of Part Two are largely new, or at least, make innovative use of some existing materials. Only Chapter 11, Project Management, is virtually unchanged from the seventh edition, and even that chapter has some new materials and updating. In Part Three, Chapters 15, 16, 18, 19, and 21 are based largely on new materials, and the two chapters in Part Four on operations strategy are entirely new.

Particularly notable among the new chapters are Chapters 1, 14, 21, 22, and 23, which involve materials not found in most texts on operations management. Chapter 1, which focuses on the role of operations in the overall competitiveness of an enterprise, is a first. This connection has been implied in the past, but it has never been focused on, isolating the competitive priorities that are the province of the operations function. In some ways related to this operations competitiveness, we have presented a full chapter on Japanese manufacturing systems in Chapter 14.

Another first for operations management texts is Chapter 21 on multicriteria decision methods for production problems. Although we have long recognized that most decisions in operations management have multiple criteria, virtually all the formal decision models used involved a single criterion. Here we present methodology for casting decisions in a more realistic, multiple criteria environment.

Finally, with Chapters 22 and 23, we devote two chapters to operations strategy, the first dealing with operations strategy formulation and the second with the implementation of operations strategy. These chapters reflect the growing importance of operations strategy as an integral part of corporate strategy. Every student, whether concentrating in operations management or not, needs to understand operations strategy in order to make decisions that take this important function into account and, even more important, to manage strategically on a day-to-day basis.

Elwood S. Buffa
Rakesh K. Sarin

ACKNOWLEDGMENTS

Materials in this book have been drawn from a wide variety of sources, including original work by scores of colleagues around the world. The sources of these works are cited where they are discussed in the text, and we hope that we have made no omissions.

Reviewers of the seventh edition and of the revised manuscript provided reactions that were invaluable for the preparation of the eighth edition. They were Solon Morgan of Drexel University; Colonel Allen Grum of the U.S. Military Academy—West Point; James Black of Miami University; Fred Rafaat of Wichita State University; M.H. Safizadeh of Wichita State University; Norman Ware of Eastern Illinois University; and David Carhardt of Bentley College.

We are deeply indebted to these colleagues for taking the time and effort to review such extensive and complex materials and for providing reactions and recommendations for improvement. We recognize that the book is better for their inputs.

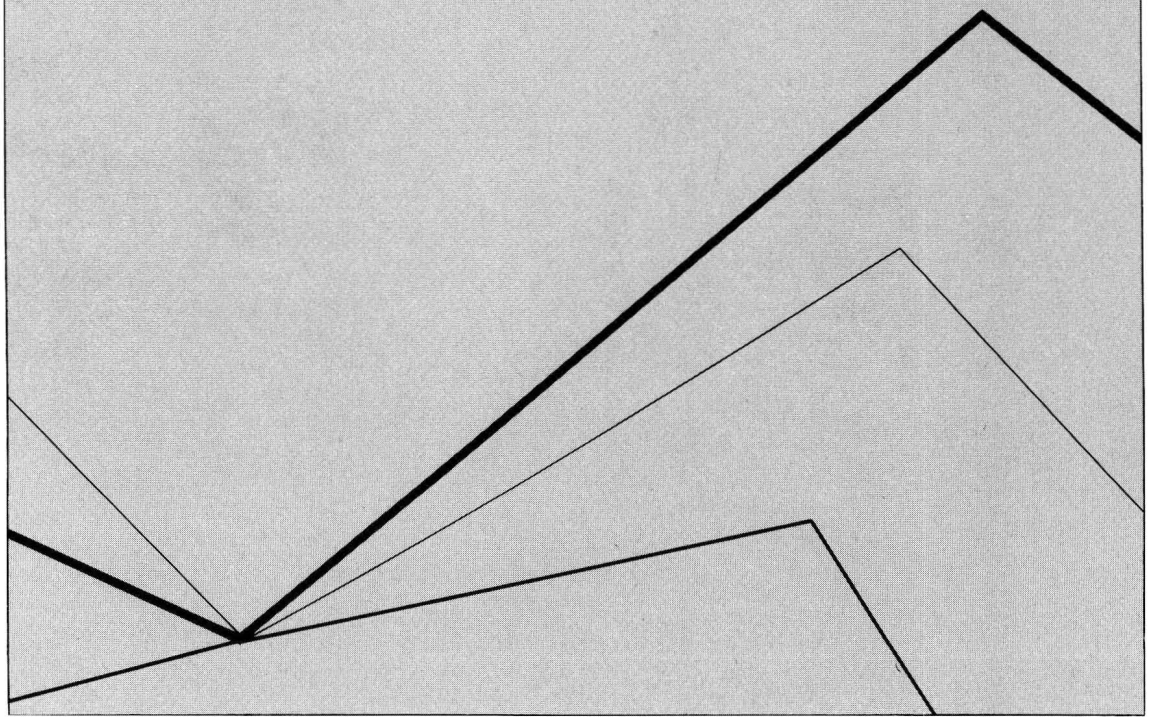
The forty or more reviewers of previous editions represent a cross-section of the outstanding professors of production and operations management in the country. They have had an important role in the development and evolution of *Modern Production/Operations Management* over its long life. We sincerely thank them for their many suggestions and comments.

E.S.B.
R.K.S.

CONTENTS

PART ONE

CLASSIFICATION AND IMPORTANCE OF OPERATIONS MANAGEMENT



CHAPTER 1

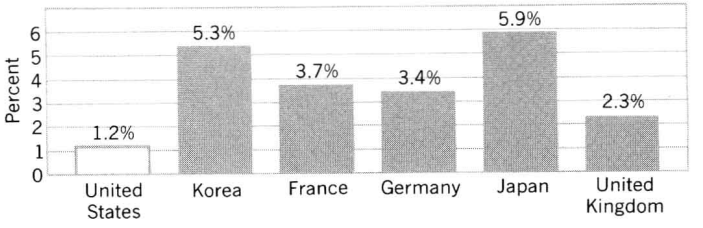
OPERATIONS MANAGEMENT IN CORPORATE PROFITABILITY AND COMPETITIVENESS

The President's Commission on Industrial Competitiveness states: "Universities need to improve the quality and quantity of their manufacturing-related curriculums. We need more technical courses in process-related subjects and more emphasis on courses in manufacturing management."[1] We heartily agree, and the purpose of this book is to provide effective teaching material to help achieve these objectives. The evidence concerning our global competitiveness indicates that, in order to become competitive, we must manage our productive systems more effectively. This means that top management must place greater emphasis on the operations function, understand it more effectively, and put a higher priority on incorporating it into the enterprise strategy.

Sleeping giants begin to move as corporations throughout the United States realize the importance of the production or operations functions to the success of their businesses; that is, the strategic importance of producing value for the marketplace. This realization has been the result of competition. While competition has always been a potent force in free economies, in recent years its scope has expanded, as over 70 percent of our goods must now operate in a global marketplace.

News stories concerning the loss of market share and jobs to foreign competition have been commonplace in the 1980s, particularly competition from Japanese manufacturers. Not only has the scope of competition become global, but much of the devastating intrusion into both U.S. and foreign markets formerly dominated by U.S. producers has been based on the ability of foreign companies to manufacture at lower costs products of higher quality than American manufacturers could achieve. Cost and quality are characteristics that must be designed into a product in the first place, but achieving them in the final product is the result of carefully managing the

FIGURE 1-1
AVERAGE ANNUAL PERCENT CHANGE IN PRODUCTIVITY (REAL GROSS DOMESTIC PRODUCT PER EMPLOYED PERSON, 1960–83).



Source: Global Competition: The New Reality, Report of the President's Commission on Industrial Competitiveness, Volume I, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., January 1985.
Data source: U.S. Department of Labor, Bureau of Labor Statistics.

[1] *Global Competition: The New Reality,* Report of the President's Commission on Industrial Competitiveness, Superintendent of Documents, U.S. Government Printing Office, Washington, DC, January 1985, p. 24.