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Production and Operations Management

Manufacturing and
Nonmanufacturing

THIRD EDITION

James B.
Dilworth

Third Edition

PRODUCTION AND OPERATIONS MANAGEMENT

Manufacturing and Nonmanufacturing

James B. Dilworth

University of Alabama at Birmingham



Random House

Business Division

New York

D*edicated with love
to Ginger, Jimmy, Caroline,
Jessica Leigh, and Michael,
and to the memory of my father,
my mother, and Andrew*

Third Edition

98765432

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PREFACE TO THE THIRD EDITION

The third edition of *Production and Operations Management: Manufacturing and Nonmanufacturing*, and the ancillaries that are available to use with it, should provide valuable tools for teaching operations management to students today. The text has been revised to reflect recent developments in a field which is changing rapidly and becoming more widely recognized for its strategic importance. Although there are many smaller changes throughout the text, some of the more important changes are mentioned below.

First of all, plant tours have been added to provide some introduction to what happens in manufacturing operations, since most students have been in banks, restaurants, hospitals or other nonmanufacturing operations, but many have never been in a factory. The text also incorporates many new current topics, including just-in-time manufacturing, the growing use of computers and automation, the use of group technology or cellular manufacturing, and the idea of flexible manufacturing systems, that incorporate all of these factors. A new chapter on scheduling service operations has been provided, and all of the chapters have been updated and improved. The material within the quality assurance and aggregate planning chapters has been resequenced to improve the presentation. The supplements have been retained, but the material on investments and the time value of money has been deleted because our user survey indicated that this material was not used, since it was covered in finance and accounting courses.

Ancillary Materials For the convenience of teachers and students, a number of ancillary materials are available to supplement this book:

A *Study Guide with Problems and Cases* by Larry Ettkin and myself can be purchased by students as an addition to the text. In addition to standard self study features such as learning objectives, detailed chapter summaries and true-false and multiple-choice questions, the guide provides further examples of solved problems (reinforcing this approach in the text), unsolved problems for working, and additional readings and cases on current and important issues in operations management.

The *Solutions Manual*, which is available to professors, provides detailed solutions to all end-of-chapter questions and problems. It also contains solutions

to unsolved problems and suggested responses to discussion questions in the study guide.

The *Instructor's Resource Manual* helps the instructor use the text effectively. It provides Learning Objectives, Lecture Outlines and Notes, and Transparencies, along with an Instructor's Test File of problems and solutions to test students' knowledge.

Software that can be used with this text is also available from Random House. A set of Lotus templates is available with extensive macro programs to perform operations management calculations. Also, an operations management "tool kit," which is software for solving operations management problems of many different types, such as those the practitioner might face, can be purchased through Random House.

Structure of the Text The book is designed to describe different types of operations and then discuss early in the book the importance of operations in a company's pursuit of its strategic goals and objectives. In developing its strategy a company defines what business it is in—that is, what goods or services it offers in what territories and by what methods they are to be provided. After doing so, a company is better able to forecast the demand for these products and, hence, to estimate the level of operations the company should be prepared to provide. Part I of the book is designed to present these concepts.

A demand forecast, or projection of future demand, is the basis for two major categories of decisions about operations: (a) designing the operations system and (b) planning and controlling the efforts of that system. Part II of the book discusses management issues related to planning and controlling operations efforts. Part III discusses design-related issues and contains a concluding chapter.

Although the material in this course can be covered in various sequences, I chose to provide more material related to running an operations system and to present it before design-related material because of several considerations.

- This sequence fits the life cycle of the *student* who is preparing for the world of work. Most students will be employed initially in a position that relates to an ongoing system and may later be involved in designing one. Few will have an initial assignment to design some type of production and operations system.
- The greatest percentage of students who take the introductory production and operations management course will interface with an ongoing production system. For those who go into marketing or finance and those whose only interaction with a production system is as consumers, it will be most important to understand how the production system works. The smaller percentage of students who will become involved in designing production and operations systems will receive training beyond the course for which this text is used.
- In terms of design logic, one must first understand the functions of a system in order to develop the most appropriate design for that system.

One would not design an automobile or airplane without first developing an understanding of how the machine operates.

The material within each chapter is structured to provide flexibility. Generally, the first part of each chapter introduces a topic, discusses why it is important, and relates it to the field of operations management. The application of tools, methods, and techniques generally is discussed in the latter part of a chapter or in a chapter supplement. This structure enables a professor to teach a descriptive course by omitting, or not emphasizing, the latter parts of the chapters and the quantitative supplements and using mostly discussion questions and cases, instead of problems. For a more quantitative course, one can devote more class time to the tools and problems and let the students read the chapters' introductory discussion material outside of class.

Acknowledgments This book has drawn on the talents, advice, and encouragement of more people than I can possibly acknowledge. I would, however, like to recognize the contributions of many who have helped. First, I want to thank my family, who have persevered with me even though we grew a little weary before this project was completed. I want to thank Gene Newport, Robert Ford, and my other colleagues at UAB for their encouragement and interest. The assistance of David Dannenbring of Columbia University, who carefully checked all the quantitative material in the text, *Solutions Manual*, and test file, was an invaluable help in ensuring the accuracy of this text. I am very grateful to June Smith, Susan Badger, Niels Aaboe, Anne Mahoney, Andrew Roney, and the other staff members at Random House who have worked so hard to make this project a success.

I greatly appreciate the comments and splendid advice of the academics who reviewed this edition: Frank C. Barnes, University of North Carolina at Charlotte; Thomas E. Callarman, Arizona State University; C. W. Dane, Oregon State University; Gene K. Groff, Georgia State University; Peter Haug, University of Washington; Yunus Kathawala, Eastern Illinois University; John F. Kottas, College of William and Mary; Bruce J. McLaren, Indiana State University; J. Roberta Minifie, Texas Tech University; C. Carl Pegels, State University of New York—Buffalo; and R. Daniel Reid, Bowling Green State University. I am grateful as well to those individuals, too numerous to mention by name, who responded to a survey which formed the basis for the revision of the text.

I also want to express my gratitude to Betty Smith, who typed the material for the ancillaries and who assists our department in so many kind ways.

Finally, I want to thank you, THE READER, for taking time to read this far. I hope that you will read the book and use it to benefit many. As with the first and second editions, I welcome your comments about how this book can be improved.

JAMES B. DILWORTH
Birmingham, Alabama
October 1985

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PART I

FOUNDATION

MATERIAL

Part I of this book contains three chapters and four informational supplements. Together they provide a foundation for the further study of production and operations management. Chapter 1 introduces the operations function in manufacturing and nonmanufacturing settings and briefly reviews some of the activities of operations managers. Two types of manufacturing operations introduced in the first chapter are continuous- and intermittent-production plants. Supplement A, the first supplement to follow Chapter 1, provides a verbal tour of a plant engaged in continuous production, and Supplement B, the next one, provides a tour of a plant engaged in intermittent production—providing further insight into these two types of operations. Supplement C briefly reviews the history of, and current developments in, production and operations management in the United States.

The operations function is a vital component of a business, making major contributions to achievement of the company's strategic plans. Chapter 2 discusses how operations relate to the long-range, strategic decisions that managers make to guide a company. Supplement D, which follows Chapter 2, provides an overview of the decision-making process and the use of models in decision making.

Managers must make decisions based on inferences about the future. They must attempt to answer such difficult questions as What future developments do we need to be planning for and reaching decisions about? What will be the outcome of each possible course of action we might take? Forecasting, the basis for much of management's planning and control activities, is the subject of Chapter 3.

Forecasts may reveal a need for decisions in either of the two major categories that constitute Parts II and III of the book. Forecasts help managers make decisions relating to the short- to intermediate-term *operation* of the production system—issues that are discussed in Part II. Forecasts also are the basis for decisions pertaining to longer-term changes in the *design* of the production system—issues that are discussed in Part III.