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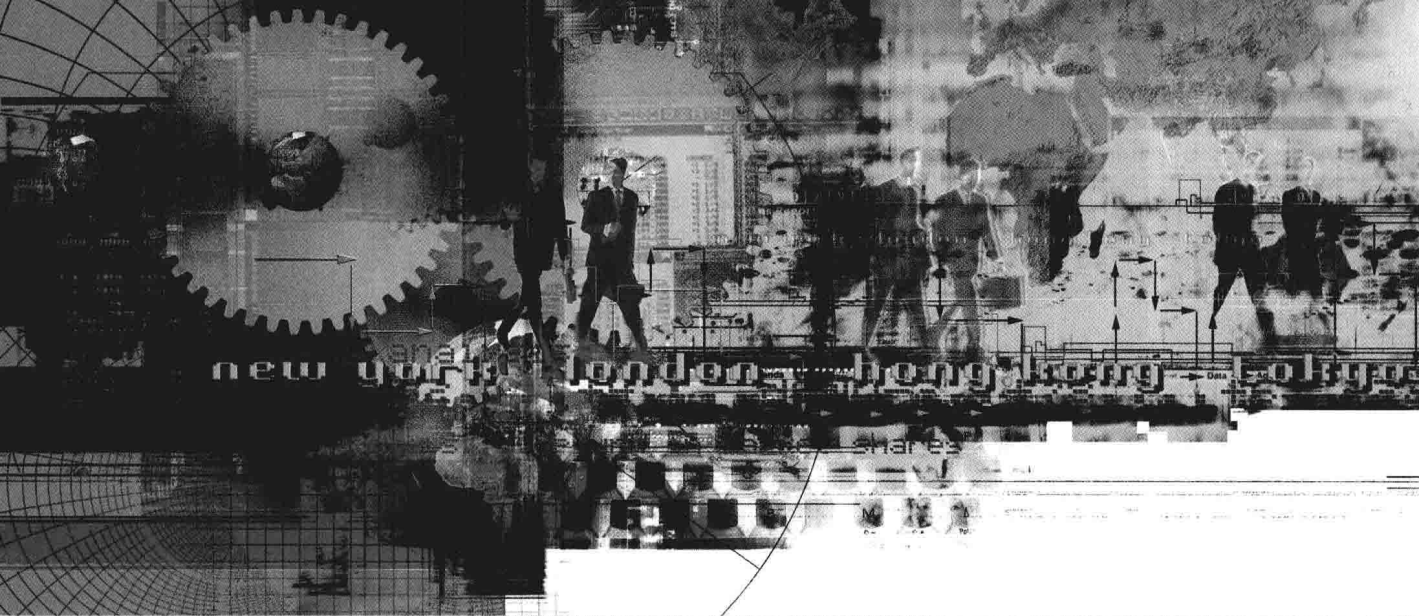
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Operations MANAGEMENT

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Fundamentals of Operations Management

Fourth Edition

Mark M. Davis

Bentley College

Nicholas J. Aquilano

The University of Arizona

Richard B. Chase

University of Southern California



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***To our wives
Cookie, Nina, and Harriet***

***And to our children
Andy and Alex
Don, Kara, and Mark
Laurie, Andy, Glenn, and Rob***

About the Authors

Mark M. Davis Dr. Davis is professor of Operations Management at Bentley College in Waltham, MA. He received his BS degree in Electrical Engineering from Tufts University and his MBA and DBA degrees from Boston University's School of Management. He worked as a manufacturing engineer for the General Electric Company and is a graduate of its Manufacturing Management Program. He was also a programs manager for the U.S. Army Natick Research Laboratories.

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Recent articles include "Want to Perfect Your Company's Service? Use Behavioral Science" (with S. Dasu), forthcoming in the *Harvard Business Review*; "Constructing an Empirically Derived Measure for Customer Contact" (with D. Kellogg) in *Management Science*; "Beefing Up Operations in Service Firms" (with R. Hayes) and "Make Your Service Failsafe" (with D. Stewart), both in the *Sloan Management Review*; "The Mall Is My Factory: Reflections of a Service Junkie" in *Production and Operations Management*; and "The Strategic Levers of Yield Management" (with S. Kimes) in *The Journal of Service Research*.

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Preface

Operations management continues to be an evolving discipline. Just as the economies of the major countries of the world were once largely dependent on manufacturing for growth, operations management initially focused almost exclusively on manufacturing-related issues. In the last 20 years, however, the field of operations management has changed dramatically. The reasons are many, including: (a) the emergence of a truly global economy, (b) significant advances in technology, specifically information economy, and (c) the continued growth of services in all of the world's economies, to the point where services now represent a major portion of the economies in the more highly developed countries.

For these same reasons, the fundamentals of managing a business, in general, have also changed. No longer are the functional areas within a firm seen as being independent from each other; instead they are viewed as being interrelated. As a consequence, operations management cannot be studied in isolation from marketing and finance. Equally important, the study of operations management is no longer confined to manufacturing. Today, operations management also includes services. In addition to the growing importance of services in today's economies, manufacturers are also recognizing the need to provide their customers with high-quality service, which can provide them with a significant advantage in today's highly competitive environment.

A major goal of this edition of *Fundamentals of Operations Management* is to reflect these changes that have taken place in business. The inclusion of services has always been a hallmark of *Fundamentals of Operations Management*. This fourth edition continues to set the standard by placing even greater emphasis on services, and the need for manufacturing and services to become more fully integrated in order to better meet customer requirements. To reinforce this emphasis on services, examples from a wide variety of service organizations have been liberally included throughout the text to provide students with both a link between theory and practice, as well as a contemporary view of operations management.

Another goal of this fourth edition has been to acknowledge the significant impact of technology on the study of operations management. As we embark on the twenty-first century, technology, and especially information technology, continues to change the ways in which companies do business. And we are seeing only the tip of the iceberg. Technology will continue to advance in the form of faster and more accurate transmission lines, more powerful computers, and larger electronic data storage equipment that is capable of storing *petabytes* of data (1 petabyte = 1,125,899,906,842,624 bytes). At the same time, unit costs in all of these areas will continue to decrease.

In addition, barriers to trade across national borders continue to be lowered with the creation of regional free trade zones such as the European Union, the North American Free Trade Agreement (NAFTA), and Mercusur (a free trade agreement among several South American countries).

The combination of advances in technology and lower trade barriers has facilitated the world's economies to continue their trend toward a single *global village* or *global landscape*. Both customers and suppliers now exist in every corner of the world, with no company being immune to international competition. In such a hypercompetitive environment, it is imperative that managers continue to develop innovative applications for these new technologies as they become available. This ever-changing environment has a significant impact on the operations management function in terms of how goods and services are produced and delivered.

To address these changes, as well as to link theory with practice, this fourth edition provides

- New coverage and emphasis on several topics in operations management that are currently high-priority issues with both business and operations managers. Two new chapters are devoted to this coverage: new product and service development (Chapter 3) and the role of technology in operations management (Chapter 4).
- A pedagogical feature, entitled “Managerial Issues,” begins the text in each chapter to provide students with not only a managerial framework for the topic, but also an understanding of how the topic contributes to the success of the organization.
- The continued development of relevant concepts in operations management that are now recognized as critical success factors in business. These include yield management (Chapters 15 and 16), which focuses on maximizing capacity utilization and profits in service operations, and supply chain management (Chapter 13), which addresses both the changing role of the supplier and the fact that supply chains are becoming longer as firms now look to the four corners of the world for suppliers.
- Recognition that the operations function in every organization involves individuals and that their role is changing as are the organizations themselves. As part of these changes, there is an increasing emphasis on teamwork (Chapters S3 and 10).
- Demonstration of how operations management needs to be fully integrated with the other functional areas within an organization, and that many of the operations management tools are being applied in these other functional areas, such as marketing, engineering, and finance. For example, business process analysis can show engineering managers how to accelerate the development and introduction of new products (Chapters 3 and 4), and just-in-time (JIT) concepts (Chapter 14) are used to market mass-customized products that can be delivered to customers with minimal delays. These tools and techniques from operations management are also now used in a wide variety of new applications that go far beyond the walls of the traditional factory. As an illustration, quality management tools (Chapter S6) such as statistical process control (SPC) are now used to predict impending medical problems for patients with asthma or congestive heart failure.

We tried to do this in a brief and interesting way, focusing on core concepts and utilizing quantitative techniques only where necessary while making the mathematics intuitive and less formal.

Specific Objectives of This Book

Most students do not major in operations management. In fact, many schools and colleges do not even offer a major in operations management. Nevertheless, it is important for you to understand how the operations management function contributes to the overall success of an organization. The reasons are twofold. First, understanding how the different elements within the OM function fit into the overall organizational structure will provide you with a broader perspective that, in turn, will allow you to do your own job better. In addition, as we stated above, the concepts developed initially within the OM function have application in all of the other functional areas within an organization. Understanding and applying these tools and concepts can improve your ability to be both effective and efficient in the way you do your work.

Many students don't appreciate the importance of operations management until after they graduate and begin work. For example, consider the "hot" employment area of information technology (IT). Specialists in IT really should have a working knowledge of the best practices in process management, forecasting, quality control, and project planning to correctly apply many of the software tools that they will encounter on the job.

For these reasons, the specific objectives of this book are to



1. Introduce the various elements that comprise the field of operations management, and some of the new and evolving concepts within OM.
2. Identify some of the OM tools and concepts that can be applied to a wide variety of situations, including non-OM-related areas.
3. Develop an appreciation of the need for interaction between operations management and the other management functions within an organization.
4. Explain the role of technology in operations management and its impact on the different OM elements.
5. Describe the growing trend toward globalization among firms and how it affects operations management.
6. Demonstrate that manufacturing and services are becoming more integrated within companies.
7. Provide an integrated framework for understanding the field of OM as a whole and its role in an organization.

With respect to the last objective, our goal is to demonstrate that operations management is not just a loosely knit aggregation of tools but rather a *synthesis* of concepts and techniques that relate directly to operating systems and enhance their management. This point is important because OM is frequently confused with operations research (OR), management science (MS), and industrial engineering (IE). The critical difference between OM and these fields is this: OM is a field of management, whereas OR and MS are branches of applied mathematics and IE is an engineering discipline. Thus, while operations managers use the tools of OR and MS in decision making, and are concerned with many of the same issues as IE, OM has a distinct business management role that differentiates it from OR, MS, and IE.

Special Features of the Book

In an attempt to facilitate the learning process, we have incorporated several pedagogical features, including

- *Chapter objectives.* At the beginning of each chapter, a list of objectives is presented to highlight the important concepts on which the chapter focuses.
- *Vignettes.* Each chapter begins with a short vignette that shows how the chapter topic is actually applied in a real-world setting, to create student interest for the chapter material.
- *Application of OM concepts.* Examples of how many of the OM concepts presented in this text are applied in actual business situations are provided throughout the text. The use of real-world examples reinforces the critical role of operations management, showing how it contributes to the overall success of an organization. These applications take several forms, including the opening vignette to each chapter and Operations Management in Practice boxes, as well as in the numerous examples that are included throughout the text itself.

- *Internet exercises.* The Internet continues to be a powerful tool for obtaining and disseminating information, and this information is constantly changing. Where appropriate, an Internet exercise is provided at the end of a chapter to encourage students to obtain the latest information on a particular topic.
- *The application of Excel® spreadsheets.* Again, where appropriate, examples are provided using Excel® spreadsheets that encourage the student to explore alternative solutions.
- *Highlighting links with other functional areas.* Ideas and processes flow seamlessly across traditional functional boundaries in successful organizations, often to the point where it is practically impossible to determine where one function leaves off and another begins. To emphasize this integration within organizations, icons are used throughout the text to highlight examples of how OM is linked to other functional areas.
- *Global perspective.* Another feature of the book is its emphasis on the global impact of operations today; where appropriate, we show how the concepts apply in a global context. Special icons are used in the book to highlight this area.
- *Margin definitions.* Key terms are in boldface when first defined and definitions added in the margin. At the end of the chapter these key terms are listed with page numbers for quick student reference.
- *Full-color art.* This fourth edition includes photos and exhibits to enhance the visual appeal and interest of students, to clarify and extend the text discussions, and to help students see operations in action.
- *Examples with solutions.* Examples follow quantitative topics and demonstrate specific procedures and techniques. These are clearly set off from the text and help students understand the computations.
- *Formula review.* Key formulas and equations are numbered within each of the more quantitative chapters and are repeated in summary form at the end of those chapters for easy student review.
- *Solved problems.* Representative example problems are included at the end of appropriate chapters. Each includes a detailed, worked-out solution and provides another level of support for students before they try homework problems on their own.
- *Review and discussion questions.* These questions allow students to review the chapter concepts before attempting the problems and provide a basis for classroom discussion. Suggested responses are included in the Instructor's Manual.
- *Problems.* A wide range of problem material follows each chapter, asking students to solve realistic, interesting problems.
- *Cases.* Located at the end of most chapters, short cases allow students to think critically about issues discussed in the chapter. These also can provide good classroom discussions or provide a capstone problem for the chapter. We've included both long and short cases such as Kristen's Cookie Company from Harvard.



Ancillary Materials

- *Student CD-ROM,* packaged with each copy of the text, contains chapter quizzes, Excel® spreadsheets, PowerPoint® slides, and short video clips illustrating key operations topics.

- *Instructor's Resource CD-ROM* is an all-in-one resource offered to adopters of the text. It contains the Instructor's Manual, Test Bank, and PowerPoint slides (described below), as well as video clips, all text exhibits, and Excel templates.
 - *Instructor's Manual*, prepared by Ross Fink of Bradley University, includes answers to discussion and review questions and solutions to text problems. There is a useful reference grid showing which problems correspond to specific topics in the chapters for ease in assignment.
 - *Test Bank*, prepared by Daniel Tracy of University of Tennessee at Martin, provides true/false, multiple/choice, and narrative problems for each chapter. Along with the manual, a separate computerized testing package is available allowing instructors to generate, add, and edit questions; save and reload tests; and select questions based on type or level of difficulty.
 - *PowerPoint Presentation Slides*, prepared by Charlie Cook of University of West Alabama, provides lecture outlines plus graphic material from the text to complement and customize lectures.
- **Videos. The Irwin Operations Management Video Series** consists of 29 segments on eight volumes covering quality, inventory, lean production, computer-integrated manufacturing, production processes and services, and global supply chains. They show students chapter concepts at work and how critical operations management is to organizations such as Motorola, Toyota, Hewlett-Packard, United Airlines, and others.
- *Operations Management Center Website* (<http://www.mhhe.com/pom/>). This site supports students and faculty in search of resources related to all aspects of operations management. There are sites with company tours, organizations, on-line publications, resources by topic, and textbook support.

We also have tried to practice what we preach. In applying the quality concept of continuous improvement, we have attempted to incorporate many of the suggestions made by our reviewers.

There is an old Chinese proverb that states, "May you live in interesting times." Like it or not, from an operations management perspective, those "times" are now and we should take full advantage of the opportunity—and enjoy it while doing so!

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Although only three names appear on the cover of this book, a project of this magnitude could not be successfully completed without the assistance and cooperation of many individuals. Specifically, we would like to thank the reviewers for their evaluation of the second edition text and for their manuscript reviews. We thank them for their suggestions and comments. They include

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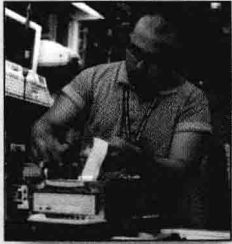
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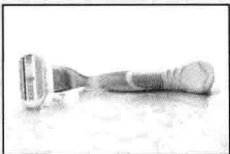
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