

Operations Management 8e

Processes and Value Chains

Lee
Krajewski
Ritzman
Manoj
Malhotra

OPERATIONS MANAGEMENT

Processes and Value Chains

EIGHTH EDITION

LEE J. KRAJEWSKI
University of Notre Dame

LARRY P. RITZMAN
Professor Emeritus at
The Ohio State University
and Boston College

MANOJ K. MALHOTRA
University of South Carolina



Upper Saddle River, New Jersey 07458

Library of Congress Cataloging-in-Publication Data

Krajewski, Lee J.

Operations management processes and value chains / Lee J. Krajewski, Larry P. Ritzman, Manoj K. Malhotra.—8th ed.

p. cm.

Includes bibliographical references and index.

ISBN 0-13-187294-X

I. Production management. I. Ritzman, Larry P. II. Malhotra, Manoj K. III.

Title.

TS155.K785 2007

658.5—dc22

2005058688

AVP/Executive Editor: Mark Pfaltzgraff

Editorial Director: Jeff Shelstad

Senior Project Manager: Alana Bradley

Editorial Assistant: Barbara Witmer

Developmental Editor: Amy Ray

Media Product Development Manager: Nancy Welcher

AVP/Executive Marketing Manager: Debbie Clare

Marketing Assistant: Joanna Sabella

Senior Managing Editor (Production): Cynthia Regan

Production Editor: Melissa Feimer

Permissions Supervisor: Charles Morris

Manufacturing Buyer: Diane Peirano

Design Manager: Christy Mahon

Art Director: Janet Slowik

Interior Design: Amanda Kavanagh

Cover Design: Ray Cruz

Illustrator (Interior): ElectraGraphics, Inc.

Director, Image Resource Center: Melinda Reo

Manager, Rights and Permissions: Zina Arabia

Manager, Visual Research: Beth Brenzel

Image Permission Coordinator: Debbie Latronica

Photo Researcher: Teri Stratford

Manager, Print Production: Christy Mahon

Composition/Full-Service Project Management: BookMasters, Inc.

Printer/Binder: Quebecor

Credits and acknowledgments borrowed from other sources and reproduced, with permission, in this textbook appear on appropriate page within text (or on page 709).

Microsoft® and Windows® are registered trademarks of the Microsoft Corporation in the U.S.A. and other countries. Screen shots and icons reprinted with permission from the Microsoft Corporation. This book is not sponsored or endorsed by or affiliated with the Microsoft Corporation.

Copyright © 2007, 2005, 2002 by Pearson Education, Inc., Upper Saddle River, New Jersey, 07458.

Pearson Prentice Hall. All rights reserved. Printed in the United States of America. This publication is protected by Copyright and permission should be obtained from the publisher prior to any prohibited reproduction, storage in a retrieval system, or transmission in any form or by any means, electronic, mechanical, photocopying, recording, or likewise. For information regarding permission(s), write to: Rights and Permissions Department.

Pearson Prentice Hall™ is a trademark of Pearson Education, Inc.

Pearson® is a registered trademark of Pearson plc

Prentice Hall® is a registered trademark of Pearson Education, Inc.

Pearson Education LTD.

Pearson Education Singapore, Pte. Ltd

Pearson Education, Canada, Ltd

Pearson Education—Japan

Pearson Education Australia PTY, Limited

Pearson Education North Asia Ltd

Pearson Educación de Mexico, S.A. de C.V.

Pearson Education Malaysia, Pte. Ltd



10987654321
ISBN 0-13-187294-X

DEDICATED with love to our families.



Judie Krajewski

Gary

Lori and Dan; Aubrey, Madeline, and Amelia

Carrie and Jon; Jordanne and Alaina

Selena and Jeff

Virginia and Jerry

Virginia and Larry



Barbara Ritzman

Karen and Matt; Kristin and Alayna

Lisa and Todd; Cody, Cole, Taylor, and Clayton

Kathryn and Paul

Mildred and Ray



Maya Malhotra

Vivek, Pooja, and Neha

Santosh and Ramesh Malhotra

Indra and Prem Malhotra; Neeti and Deeksha

Sadhana Malhotra

Leela and Mukund Dabholkar

Aruna and Harsha Dabholkar; Aditee

Mangala and Pradeep Gandhi; Priya and Medha

PREFACE

The Eighth Edition of *Operations Management* by Lee Krajewski, Larry Ritzman, and new co-author **Manoj Malhotra** has many exciting changes. Highlights of these changes are as follows:

NEW! Co-Author: Manoj Malhotra, the Jeff B. Bates chair at the University of South Carolina, was asked to join this team because of his teaching ability, his active research record, and his success as a consultant to such top firms as John Deere, Metso Corporation, Phelps Dodge, Sonoco, Milliken, and Verizon among others. Above all, Manoj is a master teacher who knows how to teach operations management creatively and effectively at both the undergraduate and MBA level. He has taught from the book since the first edition and brings new energy and ideas to this edition. Examples of his many contributions to the pedagogical quality of the eighth edition include:

- *Chapter 7, "Constraint Management."* He elevates the discussion of the theory of constraints, explains how to identify and manage bottlenecks, and introduces bottleneck-based product-mix selection techniques that dovetail with the Min-Yo Garment Company Experiential Learning Exercise.
- *Chapter 9, "Lean Systems,"* moved forward in the book, includes fresh Managerial Practice examples, and connects lean systems with poka-yoke methods, the Five S concept, and value stream mapping. These changes help tie together the first nine chapters of the book and reinforce the notion of viewing operations from a process management perspective, which then transitions to managing value chains in Part 3 of the book.
- *Chapter 11, "Location,"* is more contemporary and practically-oriented with a strong decision-making focus. Manoj introduces such innovations as GIS-based location methods using Microsoft MapPoint 2004. There are videos on its use, along with new location examples and a new end-of-chapter case.

NEW! Starwood Case and Video Integration: Another notable change to the eighth edition is the introduction of six Managerial Challenge cases based on Starwood Hotels and Resorts. This case material, and the accompanying video footage, illustrates chapter topics through the eyes of Starwood, one of the world's largest hotel companies.

NEW! Design and Organization: The book is streamlined, with fewer pages and an attractive design that lends a much different "look and feel" to the eighth edition. The art is completely redone to correspond with the design, and it has many innovative features. However, the innovations go far beyond cosmetics. Substantive changes have been made in almost every chapter and supplement, without losing the main themes that have been so valued in the past editions. For example:

- **Theme:** The two dominant themes of processes and value chains have been further reinforced with considerable attention being paid to service providers. A central figure in the margin of each chapter's introduction makes the point, as do the brief discussions on how the chapter relates to both processes and value chains and to the firm's various functional areas.
- **Part 1:** Chapter 1, "Operations As a Competitive Weapon," presents China and India as two notable countries affecting global competition and introduces the first of six Managerial Challenges. Chapter 2, "Operations Strategy," has a new section on order winners

PREFACE

and qualifiers, plus a new example of closing the gap in performance using operations strategy, and cuts tangential discussion. Chapter 3, “Project Management,” is earlier in the book to show how projects can be used to implement operations strategy. It enhances the discussion of project risk, adds a new section on the critical chain, and has new material on the concept of earned value in projects.

- **Part 2:** Chapter 4, “Process Strategy,” identifies the strategic issues in designing processes and describes how to embed strategy into processes. Chapter 5, “Process Analysis,” streamlines the flowchart presentations and describes the many metrics that can be measured. Chapter 6, “Process Performance and Quality,” describes quality measures in the health care industry and expands the discussion of the six sigma process. Chapter 7, “Constraint Management,” brings Theory of Constraints principles to life and shows how they can be exploited to manage bottlenecks. Chapter 8, “Process Layout,” demonstrates activity settings in offices and streamlines the discussion of line balancing. Chapter 9, “Lean Systems,” connects poka-yoke methods, Five S concepts, and value stream mapping to lean approaches.
- **Part 3:** Chapter 10, “Supply Chain Strategy,” benefits from major revisions guided by faculty reviews, including detailed new material on mass customization, lean supply chains, outsourcing/offshoring, and virtual supply chains. Chapter 11, “Location,” has exciting new additions such as MS MapPoint 2004–based GIS to make real-world location decisions, complete with three new instructional videos and Solver files that facilitate calculation. Chapter 12, “Inventory Management,” brings out the cost of capital concept relative to holding inventory. Chapter 13, “Forecasting,” describes the forecasting process and showcases the new POM for Windows software with regression analysis. Chapter 14, “Sales and Operations Planning,” renamed to fit the terminology actually used in practice (instead of “aggregate planning”), shows how to balance supply with demand and simplifies the pure planning strategies. Chapter 15, “Resource Planning,” brings in Drum-Buffer-Rope and lean systems as part of the portfolio of resource planning systems. Chapter 16, “Scheduling,” has two new Managerial Practices addressing current scheduling approaches in service and manufacturing organizations.

ACKNOWLEDGMENTS

We wish to thank various people at Prentice Hall who make up the publishing team. Those most closely involved with the project and for whom we hold the greatest admiration include Mark Pfaltzgraff, executive editor of decision sciences, who supervised the overall project; Barbara Witmer, the editorial assistant who kept the manuscript moving through to production; Nancy Welcher, the media project development manager, who managed the production of the Student CD-ROM materials and the course management and Companion Website assets; Melissa Feimer, production editor, who kept us on schedule and helped assemble the book into the final product; Janet Slowik, art director, who delivered on a sleek new design of the book; Amy Ray, who seamlessly meshed three author voices into one; Debbie Clare, executive marketing manager, and Joanna Sabella, marketing assistant, whose marketing insights and promotional efforts make all the work of the publishing team worthwhile; and Richard Bretan and Avik Karmaker for helping make possible our media supplements while coordinating these projects through the production process. Annie Puciloski contributed her expertise to checking the text, Solutions Manual, and Test Item File for accuracy. We also express our warm gratitude to Pedro Reyes of Baylor University for writing the Instructor’s Resource Manual; Lew Hofmann of the College of New Jersey for the creation of

BRIEF CONTENTS

PART I	USING OPERATIONS TO COMPETE	2
	Chapter 1 Operations As a Competitive Weapon	3
	Supplement A Decision Making	25
	Chapter 2 Operations Strategy	45
	Chapter 3 Project Management	69
PART II	MANAGING PROCESSES	118
	Chapter 4 Process Strategy	119
	Chapter 5 Process Analysis	151
	Supplement B Simulation	187
	Chapter 6 Process Performance and Quality	205
	Chapter 7 Constraint Management	253
	Supplement C Waiting Lines	291
	Chapter 8 Process Layout	311
	Chapter 9 Lean Systems	347
PART III	MANAGING VALUE CHAINS	370
	Chapter 10 Supply Chain Strategy	371
	Chapter 11 Location	419
	Chapter 12 Inventory Management	461
	Supplement D Special Inventory Models	507
	Chapter 13 Forecasting	521
	Chapter 14 Sales and Operations Planning	567
	Supplement E Linear Programming	599
	Chapter 15 Resource Planning	623
	Chapter 16 Scheduling	671
	Appendix 1 Normal Distribution	707
	Appendix 2 Table of Random Numbers	708
	Photo Credits	709
	Name Index	711
	Subject Index	717
	CD-ROM SUPPLEMENTS	
	Supplement F Computer-Integrated Manufacturing	F1
	Supplement G Learning Curve Analysis	G1
	Supplement H Measuring Output Rates	H1
	Supplement I Acceptance Sampling Plans	I1
	Supplement J Financial Analysis	J1

CONTENTS

Preface xiii

PART I Using Operations to Complete 2**CHAPTER 1 Operations As a Competitive Weapon 3****FedEx 3**

Operations Management Across the Organization 4

A Process View 5

How Processes Work 5

Nested Processes 6

Customer–Supplier Relationships 7

Service and Manufacturing Processes 7

Adding Value: The Value Chain 8

Core Processes 9

Support Processes 10

Adding Value with Processes 10

Operations Management As a Set of Decisions 10

Managerial Practice 1.1**Operational Innovation Is a Competitive Weapon at Progressive Insurance 11**

Decision-Making Tools 12

Supporting the Firm's Goals 12

Trends in Operations Management 12

Productivity Improvement 13

Global Competition 14

Rapid Technological Change 15

Ethical, Workforce Diversity, and Environmental Issues 16

Addressing the Challenges in Operations Management 17

Managerial Practice 1.2**High-Tech Operations Help Recycle High-Tech Equipment 17**

Part 1: Using Operations to Compete 17

Part 2: Managing Processes 18

Part 3: Managing Value Chains 18

Student CD-ROM and Internet Resources 18

Key Equation 18

Managerial Challenge**Operations As a Competitive Weapon at Starwood 19**

Key Terms 19

Solved Problems 20

Discussion Questions 20

Problems 21

Active Model Exercise 22

Case Chad's Creative Concepts 23

Selected References 24

SUPPLEMENT A Decision Making 25

Break-Even Analysis 26

Evaluating Services or Products 26

Evaluating Processes 28

Preference Matrix 29

Decision Theory 30

Decision Making Under Certainty 31

Decision Making Under Uncertainty 32

Decision Making Under Risk 33

Decision Trees 34

Student CD-ROM and Internet Resources 36

Key Equations 36

Key Terms 36

Solved Problems 36

Problems 39

Selected References 43

CHAPTER 2 Operations Strategy 45**Starbucks 45**

Operations Strategy Across the Organization 47

Developing a Customer-Driven Operations Strategy 47

Corporate Strategy 47

Global Strategies 49

Market Analysis 50

Competitive Priorities and Capabilities 50

Cost 51

Quality 51

Managerial Practice 2.1**Using Operations for Profit at Costco 52**

Time 52

Flexibility 52

Managerial Practice 2.2**Building Aircraft Carriers to Customer Order 54**

Order Winners and Qualifiers 54

Using Competitive Priorities: An Airline

Example 55

New Service or Product Development 56

Development Strategies 57

Service and Product Definition 57

Development Process 59

Operations Strategy As a Pattern of Decisions 61

Student CD-ROM and Internet Resources 63

Key Terms 63

Discussion Questions 63

Case BSB, Inc., The Pizza Wars Come to Campus 65

Selected References 67

CHAPTER 3 Project Management 69**Bechtel Group, Inc. 69**

Project Management Across the Organization 70

CONTENTS

Using Projects to Implement Operations Strategy 71

Cross-Functional Interaction 71

Defining and Organizing Projects 72

Defining the Scope and Objectives of a Project 72

Selecting the Project Manager and Team 72

Organizational Structure 73

Managerial Practice 3.1

Virtual Global Teaming at Baxter International 74

Planning Projects 75

Defining the Work Breakdown Structure 75

Diagramming the Network 76

Developing the Schedule 78

Analyzing Cost–Time Trade-Offs 84

Managerial Challenge

Project Management at the Phoenixian 85

Assessing Risks 91

Managerial Practice 3.2

Boston's Big Dig Project Poses Many Challenges 92

Critical Chain 97

Resource-Related Problems 97

The Critical Chain Approach 98

Monitoring and Controlling Projects 98

Monitoring Project Status 98

Monitoring Project Resources 99

Controlling Projects 100

Student CD-ROM and Internet Resources 101

Key Equations 101

Key Terms 102

Solved Problems 102

Discussion Questions 106

Problems 106

Active Model Exercise 113

Case The Pert Studebaker 115

Selected References 117

PART II Managing Processes 118

CHAPTER 4 Process Strategy 119

Duke Power 119

Process Strategy Across the Organization 120

Process Strategy 121

Major Process Decisions 121

Process Structure in Services 122

Nature of Service Processes: Customer Contact 122

Customer-Contact Matrix 125

Service Process Structuring 126

Embedding Strategy into Service Processes 127

Managerial Practice 4.1

Processes in the Front and Back Office
at the Ritz-Carlton 128

Process Structure in Manufacturing 128

Product-Process Matrix 129

Manufacturing Process Structuring 129

Production and Inventory Strategies 131

Embedding Strategy into Manufacturing
Processes 132

Customer Involvement 133

Possible Disadvantages 133

Possible Advantages 134

Resource Flexibility 134

Workforce 135

Equipment 135

Capital Intensity 136

Automating Manufacturing Processes 136

Automating Service Processes 137

Managerial Practice 4.2

Flexible Automation at R.R. Donnelley 137

Economies of Scope 138

Strategic Fit 138

Decision Patterns for Service Processes 139

Decision Patterns for Manufacturing Processes 139

Gaining Focus 140

Strategies for Change 141

Process Reengineering 141

Process Improvement 142

Student CD-ROM and Internet Resources 142

Key Terms 143

Discussion Questions 143

Problems 143

Case Custom Molds, Inc. 145

Selected References 148

CHAPTER 5 Process Analysis 151

Omgeo 151

Process Analysis Across the Organization 153

A Systematic Approach 153

Step 1: Identify Opportunities 153

Step 2: Define the Scope 154

Step 3: Document the Process 154

Step 4: Evaluate Performance 154

Step 5: Redesign the Process 155

Step 6: Implement Changes 155

Documenting the Process 155

Flowcharts 155

Managerial Practice 5.1

Evaluating Performance at McDonald's 156

Service Blueprints 158

Process Charts 159

Evaluating Performance 161

Data Analysis Tools 161

CONTENTS

Managerial Challenge

Process Analysis at Starwood 162

Data Snooping 166

Simulation 168

Redesigning the Process 169

Generating Ideas: Questioning and

Brainstorming 169

Managerial Practice 5.2

Redesigning Processes at Baptist Memorial Hospital 170

Benchmarking 171

Managing Processes 172

Student CD-ROM and Internet Resources 173

Key Terms 173

Solved Problems 173

Discussion Questions 176

Problems 177

Active Model Exercise 183

Case José's Authentic Mexican Restaurant 184

Selected References 185

SUPPLEMENT B Simulation 187

Reasons for Using Simulation 188

The Simulation Process 188

Data Collection 188

Random-Number Assignment 190

Model Formulation 191

Analysis 192

Computer Simulation 193

Simulation with Excel Spreadsheets 193

Simulation with More Advanced Software 196

Student CD-ROM and Internet Resources 198

Key Terms 198

Solved Problem 198

Problems 199

Selected References 203

CHAPTER 6 Process Performance and Quality 205

Crowne Plaza Christchurch 205

Process Performance and Quality Across the Organization 206

Costs of Poor Process Performance and Quality 206

Prevention Costs 207

Appraisal Costs 207

Internal Failure Costs 207

External Failure Costs 207

Total Quality Management 208

Customer Satisfaction 208

Employee Involvement 210

Continuous Improvement 211

Statistical Process Control 213

Variation of Outputs 213

Managerial Practice 6.1

TQM and SPC Help ADM Cocoa Maintain a Sweet Business 214

Managerial Practice 6.2

Quality Measures in the Health Care Industry 215

Control Charts 218

Statistical Process Control Methods 220

Control Charts for Variables 220

Control Charts for Attributes 224

Process Capability 227

Defining Process Capability 227

Using Continuous Improvement to Determine the Capability of a Process 229

Quality Engineering 230

Six Sigma 230

Managerial Practice 6.3

Applying the Six-Sigma Process at Scottsdale Healthcare's Osborn Hospital 232

Six Sigma Improvement Model 233

Implementation 233

International Quality Documentation Standards 234

The ISO 9000 Documentation Standards 234

ISO 14000: An Environmental Management System 234

Managerial Challenge

Process Performance and Quality at Starwood 235

Benefits of ISO Certification 236

Malcolm Baldrige National Quality Award 236

Student CD-ROM and Internet Resources 237

Key Equations 237

Key Terms 237

Solved Problems 238

Discussion Questions 240

Problems 240

Active Model Exercise 248

Experiential Learning Statistical Process Control with a Coin Catapult 249

Selected References 251

CHAPTER 7 Constraint Management 253

Eastern Financial Florida Credit Union 253

Managing Constraints Across the Organization 254

The Theory of Constraints 255

Measuring Capacity, Utilization, and Performance in TOC 255

Key Principles of TOC 256

CONTENTS

Managerial Practice 7.1

Using TOC Principles Profits Bal Seal Engineering 258

Identification and Management of Bottlenecks 259

Managerial Practice 7.2

Constraint Management in Health Care 262

Product Mix Decisions Using Bottlenecks 263

Capacity Planning Over Longer Time Horizons 265

Economies of Scale 265

Managerial Practice 7.3

Economies of Scale at Work 266

Diseconomies of Scale 267

Capacity Timing and Sizing Strategies 268

Sizing Capacity Cushions 268

Timing and Sizing Expansion 268

Linking Process Capacity and Other

Decisions 269

A Systematic Approach to Long-Term Capacity
Decisions 270

Step 1: Estimate Capacity Requirements 270

Step 2: Identify Gaps 272

Step 3: Develop Alternatives 272

Step 4: Evaluate the Alternatives 272

Tools for Capacity Planning 273

Waiting-Line Models 273

Simulation 274

Decision Trees 274

Student CD-ROM and Internet Resources 275

Key Equations 275

Key Terms 275

Solved Problems 275

Discussion Questions 278

Problems 279

Experiential Learning Min-Yo Garment

Company 285

Case Fitness Plus, Part A 289

Selected References 290

SUPPLEMENT C Waiting Lines 291

Why Waiting Lines Form 292

Uses of Waiting-Line Theory 292

Structure of Waiting-Line Problems 292

Customer Population 292

The Service System 293

Priority Rule 295

Probability Distributions 295

Arrival Distribution 296

Service Time Distribution 296

Using Waiting-Line Models to Analyze Operations 297

Single-Server Model 298

Multiple-Server Model 300

Little's Law 301

Finite-Source Model 302

Decision Areas for Management 303

Student CD-ROM and Internet Resources 304

Key Equations 304

Key Terms 305

Solved Problems 305

Problems 307

Selected References 309

CHAPTER 8 Process Layout 311

RiverTown Crossings 311

Managing Process Layout Across the Organization 312

Layout Planning 313

Strategic Issues 313

Managerial Practice 8.1

Retailers Match Layouts to Strategies 314

Layout Types 314

Performance Criteria 316

Creating Hybrid Layouts 317

One Worker, Multiple Machines 317

Group Technology 318

Designing Flexible-Flow Layouts 319

Step 1: Gather Information 320

Step 2: Develop a Block Plan 321

Applying the Weighted-Distance Method 322

Step 3: Design a Detailed Layout 323

Other Decision Support Tools 324

Warehouse Layouts 324

Office Layouts 325

Designing Line-Flow Layouts 326

Managerial Practice 8.2

Transitioning from Traditional Layout to Activity Settings
at ABB 327

Line Balancing 328

Other Considerations 331

Student CD-ROM and Internet Resources 332

Key Equations 332

Key Terms 332

Solved Problems 332

Discussion Questions 335

Problems 335

Active Model Exercise 340

Case 1 Hightec, Inc. 341

Case 2 The Pizza Connection 343

Selected References 345

CHAPTER 9 Lean Systems 347

Toyota Production System 347

Lean Systems Across the Organization 349

CONTENTS

Characteristics of Lean Systems for Services and Manufacturing 349

Pull Method of Work Flow 349

Quality at the Source 350

Small Lot Sizes 350

Uniform Workstation Loads 351

Standardized Components and Work Methods 351

Close Supplier Ties 352

Flexible Workforce 352

Line Flows 353

Automation 353

Five S 353

Preventive Maintenance 354

Continuous Improvement Using a Lean Systems Approach 354

Managerial Practice 9.1

Lean Systems at New Balance Athletic Shoe Company 355

The Kanban System 356

General Operating Rules 357

Determining the Number of Containers 357

Other Kanban Signals 359

Managerial Practice 9.2

Lean Systems at University of Pittsburgh Medical Center Shadyside 359

Value Stream Mapping 360

JIT II 362

Operational Benefits and Implementation Issues 362

Organizational Considerations 362

Managerial Practice 9.3

Implementing Manufacturing Principles at Cessna 363

Process Considerations 364

Inventory and Scheduling 364

Student CD-ROM and Internet Resources 365

Key Equation 365

Key Terms 365

Solved Problem 365

Discussion Questions 366

Problems 366

Case *Copper Kettle Catering* 368

Selected References 369

PART III Managing Value Chains 370

CHAPTER 10 Supply Chain Strategy 371

Dell Inc. 371

Supply Chain Strategy Across the Organization 372

Supply Chains for Services and Manufacturing 373

Services 373

Manufacturing 374

Managerial Practice 10.1

Supply Chain Excellence at 7-Eleven Japan 375

Measures of Supply Chain Performance 376

Inventory Measures 376

Process Measures 379

Links to Financial Measures 379

Supply Chain Dynamics 380

External Causes 381

Internal Causes 382

Integrated Supply Chains 383

The Customer Relationship Process 383

E-Commerce and the Marketing Process 383

E-Commerce and the Order Placement Process 384

The Order Fulfillment Process 385

Inventory Placement 386

Vendor-Managed Inventories 386

Continuous Replenishment Program 387

Radio Frequency Identification 387

Distribution Processes 387

Managerial Practice 10.2

Continuous Replenishment at the Campbell Soup Company 388

Supplier Relationship Process 389

Supplier Selection and Certification 390

Supplier Relations 390

Electronic Purchasing 391

Centralized Versus Localized Buying 392

Value Analysis 393

Supply Chain Strategies 393

Strategic Focus 393

Managerial Challenge

Supply Chain Strategy at Starwood 394

Managerial Practice 10.3

A Responsive Supply Chain Helps a European Clothing Retailer Delight Customers 396

Mass Customization 397

Managerial Practice 10.4

Mass Customization at Lands' End 399

Lean Supply Chains 400

Outsourcing and Offshoring 401

Virtual Supply Chains 403

Managerial Practice 10.5

HCL Corporation Provides Service Processes in Virtual Value Chains 405

Student CD-ROM and Internet Resources 406

Key Equations 406

CONTENTS

Key Terms 406
 Solved Problem 406
 Discussion Questions 407
 Problems 408
Experiential Learning Sonic Distributors 410
Case 1 Wolf Motors 412
Case 2 Brunswick Distribution, Inc. 412
 Selected References 417

CHAPTER 11 Location 419

Bavarian Motor Works (BMW) 419

Location Decisions Across the Organization 421
 Factors Affecting Location Decisions 422
 Dominant Factors in Manufacturing 422

Managerial Practice 11.1

Relocating General Electric's Energy Division 423

Dominant Factors in Services 424
 Geographical Information Systems and Location Decisions 424

Managerial Practice 11.2

How Fast-Food Chains Use GIS to Select Their Sites 425

Using GIS to Identify Locations and Demographic Customer Segments 426

Managerial Practice 11.3

Location Challenges at Starbucks 427

Choosing Between an Onsite Expansion, New Location, or Relocation 427
 Locating a Single Facility 431
 Comparing Several Sites 431
 Applying the Load-Distance Method 432
 Using Break-Even Analysis 434
 Locating a Facility Within a Network of Facilities 436
 The GIS Method for Locating Multiple Facilities 436
 The Transportation Method 441
 Other Methods of Location Analysis 444
 Student CD-ROM and Internet Resources 444
 Key Equations 444
 Key Terms 445
 Solved Problems 445
 Discussion Questions 448
 Problems 448
 Active Model Exercise 454
Case 1 Industrial Repair, Inc. 455
Case 2 R.U. Reddie for Location 456
 Selected References 459

CHAPTER 12 Inventory Management 461

Inventory Management at Wal-Mart 461

Inventory Management Across the Organization 462
 Inventory Basics 463

Pressures for Low Inventories 463
 Pressures for High Inventories 464
 Types of Inventory 465
 Inventory Reduction Tactics 466

Managerial Practice 12.1

Improving Customer Service Through Inventory Management at Amazon.com 467

Placement of Inventories 468
 Identifying Critical Inventory Items with ABC Analysis 469

Economic Order Quantity 470

Calculating the EOQ 471
 Understanding the Effect of Changes 474
 EOQ and Lean Systems 475

Inventory Control Systems 475

Continuous Review System 475
 Periodic Review System 484

Managerial Practice 12.2

Implementing a Periodic Review Inventory System at Hewlett-Packard 486

Comparative Advantages of the Q and P Systems 488
 Hybrid Systems 489
 Inventory Record Accuracy 489
 Student CD-ROM and Internet Resources 489
 Key Equations 490
 Key Terms 490
 Solved Problems 490
 Discussion Questions 496
 Problems 496
 Active Model Exercise 501
Experiential Learning Swift Electronic Supply, Inc. 502
Case Parts Emporium 504
 Selected References 506

SUPPLEMENT D Special Inventory Models 507

Noninstantaneous Replenishment 508
 Quantity Discounts 510
 One-Period Designs 512
 Student CD-ROM and Internet Resources 515
 Key Equations 515
 Key Term 515
 Solved Problems 515
 Problems 517
 Selected References 519

CHAPTER 13 Forecasting 521

Unilever 521

Forecasting Across the Organization 523

CONTENTS

- Demand Patterns 523
- Designing the Forecasting System 524
 - Deciding What to Forecast 524
 - Choosing the Type of Forecasting Technique 525
 - Forecasting with Computers 525
- Judgment Methods 526
 - Salesforce Estimates 526

Managerial Practice 13.1

Wal-Mart Uses CPFR and the Internet to Improve Forecast Performance 527

- Executive Opinion 528
- Market Research 528
- Delphi Method 528
- Guidelines for Using Judgment Forecasts 528
- Causal Methods: Linear Regression 528
- Time-Series Methods 531
 - Naive Forecast 531
 - Estimating the Average 532
 - Including a Trend 536
 - Seasonal Patterns 538
- Choosing a Time-Series Method 541
 - Forecast Error 541
 - Criteria for Selecting Time-Series Methods 545
- Using Multiple Techniques 546
 - Combination Forecasts 547
 - Focus Forecasting 547
- Putting It All Together: Forecasting As a Process 547
 - A Typical Forecasting Process 547
 - Forecasting As a Nested Process 548
 - Student CD-ROM and Internet Resources 549
 - Key Equations 549
 - Key Terms 549
 - Solved Problems 550
 - Discussion Questions 555
 - Problems 556
 - Active Model Exercise 562
 - Case** Yankee Fork and Hoe Company 563
 - Selected References 565

CHAPTER 14 Sales and Operations Planning 567

Whirlpool Corporation 567

- Sales and Operations Planning Across the Organization 568
- The Purpose of Sales and Operations Plans 568
 - Aggregation 568
 - The Relationship of Sales and Operations Plans to Other Plans 569
- The Decision Context 571
 - Information Inputs 571

- Typical Objectives 571
- Reactive Alternatives 572
- Aggressive Alternatives 573
- Planning Strategies 574
- Relevant Constraints and Costs 574

Managerial Practice 14.1

Workforce Strategy and Commitment to Employees 575

- Sales and Operations Planning As a Process 576
- Decision Support Tools 578
- Spreadsheets 578

Managerial Challenge

Sales and Operations Planning at Starwood 579

- The Transportation Method 583
- Managerial Considerations 587
- Student CD-ROM and Internet Resources 587
- Key Terms 587
- Solved Problems 587
- Discussion Questions 591
- Problems 591
- Active Model Exercise 595
- Case** Memorial Hospital 596
- Selected References 598

SUPPLEMENT E Linear Programming 599

- Basic Concepts 600
 - Formulating a Problem 601
- Graphic Analysis 602
 - Plot the Constraints 603
 - Identify the Feasible Region 604
 - Plot an Objective Function Line 606
 - Find the Visual Solution 606
 - Find the Algebraic Solution 607
 - Slack and Surplus Variables 608
- Sensitivity Analysis 609
- Computer Solution 610
 - Simplex Method 610
 - Computer Output 610
- Applications 613
 - Student CD-ROM and Internet Resources 613
 - Key Terms 614
 - Solved Problem 614
 - Discussion Question 615
 - Problems 615
 - Selected References 621

CHAPTER 15 Resource Planning 623

Starwood 623

- Resource Planning Across the Organization 624
- Enterprise Resource Planning 624
 - What an ERP System Does 624

CONTENTS

- How ERP Systems Are Designed 625
- Planning and Controlling Systems for Manufacturers 626
- Dependent Demand 626

Managerial Practice 15.1

ERP at VF Corporation 627

- Possible Planning and Control Systems 628
- Material Requirements Planning 629
- Bill of Materials 629
- Master Production Scheduling 630
- Inventory Record 636
- Planning Factors 639
- Outputs from MRP 642
- MRP and the Environment 645
- Drum-Buffer-Rope System 646
- Resource Planning for Service Providers 647
- Dependent Demand for Services 647

Managerial Practice 15.2

The Drum-Buffer-Rope System at a U.S. Marine Corps Maintenance Center 648

- Bill of Resources 649
- Student CD-ROM and Internet Resources 650
- Key Terms 650
- Solved Problems 651
- Discussion Questions 655
- Problems 655
- Active Model Exercise 664
- Case** Flashy Flashers, Inc. 665
- Selected References 669

CHAPTER 16 Scheduling 671

Air New Zealand 671

- Scheduling Across the Organization 672
- Scheduling Service and Manufacturing Processes 673
- Performance Measures 673
- Gantt Charts 674
- Scheduling Customer Demand 675
- Appointments 675
- Reservations 675
- Backlogs 676
- Scheduling Employees 676
- Constraints 676

Developing a Workforce Schedule 677

- Computerized Workforce Scheduling Systems 679
- Operations Scheduling 679

Managerial Practice 16.1

Scheduling Employees at Call Centers 680

- Job Shop Dispatching 680
- Scheduling Jobs for One Workstation 682
- Scheduling Jobs for Multiple Workstations 686
- Scheduling Jobs for a Two-Station Flow Shop 687
- Labor-Limited Environments 689
- Linking Operations Scheduling to the Supply Chain 690
- Student CD-ROM and Internet Resources 690
- Key Equations 690

Managerial Practice 16.2

Car Sequencing at Nissan's Sunderland Plant 691

- Key Terms 692
- Solved Problems 692
- Discussion Questions 697
- Problems 697
- Active Model Exercise 701
- Case** Food King 703
- Selected References 705

Appendix 1 Normal Distribution 707

Appendix 2 Table of Random Numbers 708

Photo Credits 709

Name Index 711

Subject Index 717

CD-ROM SUPPLEMENTS

SUPPLEMENT F Computer-Integrated Manufacturing F1

SUPPLEMENT G Learning Curve Analysis G1

SUPPLEMENT H Measuring Output Rates H1

SUPPLEMENT I Acceptance Sampling Plans I1

SUPPLEMENT J Financial Analysis J1

PREFACE

the Lecture PowerPoint materials; Geoff Willis of Central Oklahoma University, who revised the Test Item File and the Online Study Guide; and Don Knox of Wayland Baptist University for revising the Instructor's Solutions Manual. This year we have several new additions to our video library and for that we owe special thanks to Beverly Amer and her colleagues at Aspenleaf Productions, Inc., as well as the folks at Starwood Hotels, Inc., who allowed us to feature their fine hotels in our new segments. We especially appreciate the creations of Howard Weiss, who updated the Active Models and the OM Explorer software materials, and who made POM for Windows available in a new version.

We also thank our colleagues at other universities who provided extremely useful guidance for all our revisions. For this edition they include the following:

Robert H. Burgess	Georgia Institute of Technology
Karen C. Eboch	Bowling Green State University
Mike Godfrey	University of Wisconsin, Oshkosh
Marilyn Helms	Dalton State University
Vijay R. Kannan	Utah State University
Dennis Krumwiede	Idaho State University
Ajay K. Mishra	State University of New York
Ken Paetsch	Cleveland State University
Taeho Park	San Jose State University
Madeleine E. Pullman	Colorado State University
Gyula Vastag	Indiana University–Purdue University, Indianapolis
Rohit Verma	University of Utah

Kudos go to Larry Meile, of Boston College, for his contributions to the Internet Exercises. Brooke Saladin's cases continue to make it easy for instructors to add interest and excitement to their classes.

At the University of Notre Dame, we want to thank Deb Coch for her Internet research and assistance in file preparation. Likewise, Jerry Wei, Dave Hartvigsen, Hojung Shin, Sarv Devaraj, and Jennifer Ryan—all of Notre Dame—were a constant source of encouragement and ideas for improvement. Patrick Philipoom, from the University of South Carolina, made stellar contributions to many of the GIS-related ideas and videos in Chapter 11 and also wrote a related end-of-chapter case. Daniel Steele, also from the University of South Carolina, served as a great sounding board and friend throughout this process. Doctoral students Alan Mackelprang and Jeff Smith at the University of South Carolina also provided valued inputs.

Finally, we thank our families for not abandoning us during our days of seclusion even when the weather for fishing or golf was perfect. Our wives, Judie, Barb, and Maya, have provided love, stability, encouragement, and a sense of humor that were needed when we were transforming the seventh edition into the eighth.

1

PART 1

USING OPERATIONS TO COMPETE

LEARNING GOALS

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

1. Define the decisions operations managers make.
2. Identify the trends and challenges facing operations management.
3. Describe operations in terms of inputs, processes, outputs, information flows, suppliers, and customers.
4. Describe operations as a function alongside finance, accounting, marketing, management information systems, and human resources.
5. Explain how operations can be used as a competitive weapon.

A FedEx employee scans a package for ground delivery. Because the Internet makes it easy for people to send documents to one another instantly, FedEx is now focusing more on its ground service.

