

JAY HEIZER BARRY RENDER CHUCK MUNSON PAUL GRIFFIN

# OPERATIONS MANAGEMENT

SUSTAINABILITY AND SUPPLY CHAIN MANAGEMENT

THIRD CANADIAN EDITION

AGRICULTURE



INDUSTRY



CONSUMERS



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# OPERATIONS MANAGEMENT

**SUSTAINABILITY AND SUPPLY CHAIN MANAGEMENT**

**THIRD CANADIAN EDITION**

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To Kathryn Ann Heizer

—JH

To Donna, Charlie, Jesse, and Reva  
and to Howard G. Kornacki, the teacher who taught  
me to love math

—BR

To Suzanne, Alexandra, Kenna, Ryan, and  
Robert Kathleen

—PG

Pearson Canada Inc., 26 Prince Andrew Place, North York, Ontario M3C 2H4.

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ISBN 978-0-13-483807-6

1 20

### **Library and Archives Canada Cataloguing in Publication**

Heizer, Jay, author

Operations management : sustainability and supply chain management / Jay Heizer, Barry Render, Chuck Munson, Paul Griffin. -- Third Canadian edition.

Includes bibliographical references and indexes.

ISBN 978-0-13-483807-6 (softcover)

1. Production management--Textbooks. 2. Textbooks.

I. Render, Barry, author II. Munson, Chuck, author III. Griffin, Paul, 1961-, author IV. Title.

TS155.H3726 2018

658.5

C2018-904040-8



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Dr. Griffin continues to write for practitioner-targeted publications and develops a continuous stream of technical manuals, materials, and courses for both the academic and industrial sectors. He remains an active member of the Editorial Advisory Board for the *Journal of Financial Planning*.

# Brief Table of Contents

## **PART ONE**

### **Introduction to Operations Management 1**

- 1** Operations and Productivity 1
- 2** Operations Strategy in a Global Environment 26
- 3** Project Management 58
- 4** Forecasting 103

## **PART TWO**

### **Designing Operations 151**

- 5** Design of Goods and Services 151  
Supplement 5: Sustainability in the Supply Chain 183
- 6** Managing Quality 203  
Supplement 6: Statistical Process Control 233
- 7** Process Strategy 264  
Supplement 7: Capacity and Constraint Management 293
- 8** Location Strategies 322
- 9** Layout Strategies 349
- 10** Human Resources, Job Design, and Work Measurement 387

## **PART THREE**

### **Managing Operations 421**

- 11** Supply Chain Management 421  
Supplement 11: Supply Chain Management Analytics 453
- 12** Inventory Management 468

- 13** Aggregate Planning and Sales and Operations Planning 512
- 14** Material Requirements Planning (MRP) and ERP 543
- 15** Short-Term Scheduling 580
- 16** Lean Operations 617
- 17** Maintenance and Reliability 643

## **PART FOUR**

### **Business Analytics Modules 661**

- A** Decision-Making Tools 661
- B** Linear Programming 681
- C** Transportation Models 711
- D** Waiting-Line Models 731
- E** Learning Curves 761
- F** Simulation 775
- Appendix A1
- Bibliography B1
- Indices I1

## **Online Tutorials**

- 1** Statistical Tools for Managers T1-1
- 2** Acceptance Sampling T2-1
- 3** The Simplex Method of Linear Programming T3-1
- 4** The MODI and VAM Methods of Solving Transportation Problems T4-1
- 5** Vehicle Routing and Scheduling T5-1

# Table of Contents

About the Authors iii

Preface xvi

## **PART ONE** **Introduction to Operations Management 1**

### **1 Operations and Productivity 1**

What Is Operations Management? 2

Organizing to Produce Goods and Services 3

*The Supply Chain 4*

Why Study Operations Management? 4

What Operations Managers Do 5

*Where Are the OM Jobs? 6*

The Heritage of Operations Management 6

Operations in the Service Sector 9

*Differences Between Goods and Services 9*

*Growth of Services 9*

*Service Pay 10*

New Challenges in Operations Management 11

The Productivity Challenge 11

*Productivity Measurement 12*

*Productivity Variables 14*

*Productivity and the Service Sector 16*

Ethics, Social Responsibility, and Sustainability 17

*Chapter Summary 18 • Ethical Dilemma*

*18 • Discussion Questions 19 • Solved Problems*

*19 • Problems 20 • Case Studies: National*

*Air Express 21 • Video Case Studies: Frito-*

*Lay: Operations Management in Manufacturing*

*22 • Hard Rock Cafe: Operations Management in*

*Services 22 • Rapid Review 23 • Self-Test 25*

### **2 Operations Strategy in a Global Environment 26**

A Global View of Operations and Supply Chains 28

*Reduce Costs 29*

*Improve the Supply Chain 30*

*Provide Better Goods and Services 30*

*Understand Markets 30*

*Learn to Improve Operations 31*

*Attract and Retain Global Talent 31*

Cultural and Ethical Issues 31

Developing Missions and Strategies 32

*Mission 32*

*Strategy 32*

Achieving Competitive Advantage Through Operations 33

*Competing on Differentiation 34*

*Competing on Cost 34*

*Competing on Response 35*

10 Strategic OM Decisions 36

Issues in Operations Strategy 39

Strategy Development and Implementation 40

*Key Success Factors and Core Competencies 41*

*Build and Staff the Organization 42*

*Integrate OM with Other Activities 42*

Strategic Planning, Core Competencies, and Outsourcing 43

*The Theory of Comparative Advantage 44*

*Risks of Outsourcing 44*

*Rating Outsource Providers 45*

Global Operations Strategy Options 47

*International Strategy 47*

*Multidomestic Strategy 48*

*Global Strategy 48*

*Transnational Strategy 48*

*Chapter Summary 49 • Ethical Dilemma 49*

*• Discussion Questions 50 • Solved Problems 50*

*• Problems 51 • Case Studies: Mr. Lube 53*

*• Video Case Studies: Operations Strategy at Regal*

*Marine 53 • Hard Rock Cafe's Global Strategy*

*53 • Rapid Review 54 • Self-Test 56*

### **3 Project Management 58**

The Importance of Project Management 59

Project Planning 60

*The Project Manager 61*

*Work Breakdown Structure 61*

Project Scheduling 62

Project Controlling 64

Project Management Techniques: PERT and CPM 65

*The Framework of PERT and CPM 65*

*Network Diagrams and Approaches 66*

*Activity-on-Node Example 67*

*Activity-on-Arrow Example 69*

Determining the Project Schedule 70

*Forward Pass 70*

*Backward Pass 72*

<i>Calculating Slack Time and Identifying the Critical Path(s)</i>	73	<i>Correlation Coefficients for Regression Lines</i>	129
Variability in Activity Times	75	<i>Multiple-Regression Analysis</i>	131
<i>Three Time Estimates in PERT</i>	76	Monitoring and Controlling Forecasts	132
<i>Probability of Project Completion</i>	77	<i>Adaptive Smoothing</i>	133
Cost–Time Trade-Offs and Project Crashing	81	<i>Focus Forecasting</i>	133
A Critique of PERT and CPM	83	Forecasting in the Service Sector	134
<i>Advantages</i>	83	<i>Specialty Retail Shops</i>	134
<i>Limitations</i>	84	<i>Fast-Food Restaurants</i>	134
Using Microsoft Project to Manage Projects	84	<i>Chapter Summary</i>	135 • <i>Ethical Dilemma</i>
<i>Entering Data</i>	84	<i>135 • Discussion Questions</i>	136 • <i>Using Software in Forecasting</i>
<i>Viewing the Project Schedule</i>	85	<i>138 • Problems</i>	139 • <i>Case Studies: Fast Creek Lightning: (B)</i>
<i>PERT Analysis</i>	86	<i>146 • Video Case Studies: Forecasting at Hard Rock Cafe</i>	146 • <i>Rapid Review</i>
<i>Tracking the Time Status of a Project</i>	86	<i>147 • Self-Test</i>	150
<i>Chapter Summary</i>	87 • <i>Ethical Dilemma</i>		
<i>87 • Discussion Questions</i>	87 • <i>Using Software to Solve Project Management Problems</i>		
<i>88 • Solved Problems</i>	88 • <i>Problems</i>		
<i>91 • Case Studies: Fast Creek Lightning: (A)</i>	96 • <i>Video Case Studies: Project Management at Arnold Palmer Hospital</i>		
<i>97 • Managing Hard Rock's Rockfest</i>	98 • <i>Rapid Review</i>		
<i>100 • Self-Test</i>	102		
<b>4 Forecasting</b>	<b>103</b>	<b>PART TWO</b>	
What Is Forecasting?	104	<b>Designing Operations</b>	<b>151</b>
<i>Forecasting Time Horizons</i>	105	<b>5 Design of Goods and Services</b>	<b>151</b>
<i>The Influence of Product Life Cycle</i>	105	Goods and Services Selection	152
<i>Types of Forecasts</i>	106	<i>Product Strategy Options Support Competitive Advantage</i>	153
The Strategic Importance of Forecasting	106	<i>Product Life Cycles</i>	154
<i>Supply Chain Management</i>	106	<i>Life Cycle and Strategy</i>	154
<i>Human Resources</i>	106	<i>Product-by-Value Analysis</i>	155
<i>Capacity</i>	106	Generating New Products	155
Seven Steps in the Forecasting System	107	<i>New Product Opportunities</i>	155
Forecasting Approaches	107	<i>Importance of New Products</i>	155
<i>Overview of Qualitative Methods</i>	107	Product Development	156
<i>Overview of Quantitative Methods</i>	108	<i>Product Development System</i>	156
Time-Series Forecasting	108	<i>Quality Function Deployment (QFD)</i>	157
<i>Decomposition of a Time Series</i>	108	<i>Organizing for Product Development</i>	160
<i>Naive Approach</i>	109	<i>Manufacturability and Value Engineering</i>	161
<i>Moving Averages</i>	109	Issues for Product Design	162
<i>Exponential Smoothing</i>	112	<i>Robust Design</i>	162
<i>Measuring Forecast Error</i>	113	<i>Modular Design</i>	162
<i>Exponential Smoothing with Trend Adjustment</i>	116	<i>Computer-Aided Design (CAD)</i>	162
<i>Trend Projections</i>	119	<i>Computer-Aided Manufacturing (CAM)</i>	163
<i>Seasonal Variations in Data</i>	122	<i>Virtual Reality Technology</i>	164
<i>Cyclical Variations in Data</i>	126	<i>Value Analysis</i>	164
Associative Forecasting Methods: Regression and Correlation Analysis	126	<i>Sustainability and Life Cycle Assessment (LCA)</i>	164
<i>Using Regression Analysis for Forecasting</i>	126	Time-Based Competition	164
<i>Standard Error of the Estimate</i>	128	<i>Purchasing Technology by Acquiring a Firm</i>	166
		<i>Joint Ventures</i>	166
		<i>Alliances</i>	166
		Defining a Product	166
		<i>Make-or-Buy Decisions</i>	167
		<i>Group Technology</i>	168

Documents for Production	169
<i>Product Life Cycle Management (PLM)</i>	169
Service Design	170
<i>Process–Chain–Network (PCN) Analysis</i>	170
<i>Adding Service Efficiency</i>	172
<i>Documents for Services</i>	172
Application of Decision Trees to Product Design	173
Transition to Production	175
<i>Chapter Summary</i>	175
• <i>Ethical Dilemma</i>	176
• <i>Discussion Questions</i>	176
• <i>Solved Problem</i>	176
• <i>Problems</i>	177
• <i>Case Studies: StackTeck</i>	179
• <i>Video Case Studies: Product Strategy at Regal Marine</i>	179
• <i>Rapid Review</i>	180
• <i>Self-Test</i>	182

## 5 Supplement: Sustainability in the Supply Chain 183

Corporate Social Responsibility	184
Sustainability	185
<i>Systems View</i>	185
<i>Commons</i>	185
<i>Triple Bottom Line</i>	185
Design and Production for Sustainability	188
<i>Product Design</i>	188
<i>Production Process</i>	190
<i>Logistics</i>	190
<i>End-of-Life Phase</i>	193
Regulations and Industry Standards	193
<i>International Environmental Policies and Standards</i>	194
<i>Supplement Summary</i>	195
• <i>Discussion Questions</i>	195
• <i>Solved Problems</i>	196
• <i>Problems</i>	197
• <i>Video Case Studies: Building Sustainability at the Orlando Magic's Amway Center</i>	199
• <i>Green Manufacturing and Sustainability at Frito-Lay</i>	199
• <i>Rapid Review</i>	200
• <i>Self-Test</i>	202

## 6 Managing Quality 203

Quality and Strategy	204
Defining Quality	205
<i>Implications of Quality</i>	206
<i>National Quality Awards</i>	206
<i>ISO 9000 International Quality Standards</i>	206
<i>ISO 14000</i>	206
<i>Cost of Quality (COQ)</i>	207
<i>Ethics and Quality Management</i>	208
Total Quality Management	208
<i>Continuous Improvement</i>	209
<i>Six Sigma</i>	210
<i>Employee Empowerment</i>	211
<i>Benchmarking</i>	211

<i>Just-in-Time (JIT)</i>	213
<i>Taguchi Concepts</i>	213
<i>Knowledge of TQM Tools</i>	214
Tools of TQM	214
<i>Check Sheets</i>	214
<i>Scatter Diagrams</i>	214
<i>Cause-and-Effect Diagrams</i>	214
<i>Pareto Charts</i>	215
<i>Flowcharts</i>	217
<i>Histograms</i>	218
<i>Statistical Process Control (SPC)</i>	218
The Role of Inspection	219
<i>When and Where to Inspect</i>	219
<i>Source Inspection</i>	220
<i>Service Industry Inspection</i>	220
<i>Inspection of Attributes versus Variables</i>	220

TQM in Services	221
<i>Chapter Summary</i>	223
• <i>Ethical Dilemma</i>	224
• <i>Discussion Questions</i>	224
• <i>Problems</i>	224
• <i>Case Studies: Fast Creek Lightning: (C)</i>	226
• <i>Video Case Studies: The Culture of Quality at Arnold Palmer Hospital</i>	227
• <i>Quality Counts at Alaska Airlines</i>	228
• <i>TQM at Ritz-Carlton Hotels</i>	229
• <i>Rapid Review</i>	230
• <i>Self-Test</i>	232

## 6 Supplement: Statistical Process Control 233

Statistical Process Control (SPC)	233
<i>Natural Variations</i>	233
<i>Assignable Variations</i>	234
<i>Samples</i>	234
<i>Control Charts</i>	235
<i>Control Charts for Variables</i>	235
<i>The Central Limit Theorem</i>	235
<i>Setting Mean Chart Limits (<math>\bar{X}</math>-Charts)</i>	237
<i>Setting Range Chart Limits (R-Charts)</i>	240
<i>Using Mean and Range Charts</i>	240
<i>Control Charts for Attributes</i>	242
<i>Managerial Issues and Control Charts</i>	245
Process Capability	246
<i>Process Capability Ratio (<math>C_p</math>)</i>	246
<i>Process Capability Index (<math>C_{pk}</math>)</i>	247
Acceptance Sampling	248
<i>Operating Characteristic Curve</i>	248
<i>Average Outgoing Quality</i>	250
<i>Supplement Summary</i>	251
• <i>Discussion Questions</i>	251
• <i>Using Software for SPC</i>	252
• <i>Solved Problems</i>	253
• <i>Problems</i>	254
• <i>Case Studies: PEI Potato Purveyors</i>	258
• <i>Video Case Studies: Frito-Lay's Quality-Controlled Potato Chips</i>	260
• <i>Farm to Fork: Quality at Darden Restaurants</i>	260
• <i>Rapid Review</i>	261
• <i>Self-Test</i>	263

## 7 Process Strategy 264

- Four Process Strategies 266
  - Process Focus* 266
  - Repetitive Focus* 267
  - Product Focus* 267
  - Mass Customization Focus* 268
  - Comparison of Process Choices* 270
- Selection of Equipment and Technology 272
- Process Analysis and Design 273
  - Flowchart* 274
  - Time-Function Mapping* 274
  - Value-Stream Mapping* 274
  - Process Charts* 275
  - Service Blueprinting* 276
- Special Considerations for Service Process Design 277
  - Customer Interaction and Process Design* 277
  - More Opportunities to Improve Service Processes* 279
- Production Technology 279
  - Machine Technology* 279
  - Automatic Identification Systems (AISs) and RFID* 280
  - Process Control* 280
  - Vision Systems* 281
  - Robots* 281
  - Automated Storage and Retrieval Systems (ASRSs)* 281
  - Automated Guided Vehicles (AGVs)* 281
  - Flexible Manufacturing Systems (FMSs)* 281
  - Computer-Integrated Manufacturing (CIM)* 282
- Technology in Services 283
- Process Redesign 284
  - Chapter Summary* 285 • *Ethical Dilemma* 285 • *Discussion Questions* 285 • *Solved Problem* 286 • *Problems* 286 • *Case Studies: Regina Manufacturing's Process Decision* 287 • *Environmental Sustainability at Walmart* 287 • *Video Case Studies: Process Strategy at Wheeled Coach Ambulance* 288 • *Process Analysis at Arnold Palmer Hospital* 288 • *Alaska Airlines: 20-Minute Baggage Process—Guaranteed!* 289 • *Rapid Review* 290 • *Self-Test* 292

## 7 Supplement: Capacity and Constraint Management 293

- Capacity 293
  - Design and Effective Capacity* 293
  - Capacity and Strategy* 296
  - Capacity Considerations* 296

- Managing Demand* 297
- Demand and Capacity Management in the Service Sector* 299
- Bottleneck Analysis and the Theory of Constraints 299
  - Theory of Constraints* 302
  - Bottleneck Management* 302
- Break-Even Analysis 304
  - Assumptions* 304
  - Graphic Approach* 304
  - Algebraic Approach* 305
  - Single-Product Case* 305
  - Multiproduct Case* 306
- Reducing Risk with Incremental Changes 308
- Applying Expected Monetary Value (EMV) to Capacity Decisions 309
- Applying Investment Analysis to Strategy-Driven Investments 309
  - Investment, Variable Cost, and Cash Flow* 309
  - Net Present Value* 309
  - Supplement Summary* 312 • *Discussion Questions* 312 • *Using Software for Break-Even Analysis* 312 • *Solved Problems* 313 • *Problems* 315 • *Video Case Study: Capacity Planning at Arnold Palmer Hospital* 318 • *Rapid Review* 319 • *Self-Test* 321

## 8 Location Strategies 322

- The Strategic Importance of Location 323
  - Location and Costs* 324
- Factors that Affect Location Decisions 324
  - Labour Productivity* 326
  - Exchange Rates and Currency Risk* 326
  - Costs* 327
  - Political Risk, Values, and Culture* 327
  - Proximity to Markets* 327
  - Proximity to Suppliers* 328
  - Proximity to Competitors (Clustering)* 329
- Methods of Evaluating Location Alternatives 329
  - The Factor Rating Method* 329
  - Locational Break-Even Analysis* 330
  - Centre-of-Gravity Method* 332
  - Transportation Model* 333
- Service Location Strategy 334
  - Geographic Information Systems* 334
  - Chapter Summary* 336 • *Ethical Dilemma* 336 • *Discussion Questions* 336 • *Using Software to Solve Location Problems* 337 • *Solved Problems* 337 • *Problems* 339 • *Case Studies: Atlantic Assembly Services* 344 • *Video Case Studies: Locating the Next Red Lobster Restaurant* 344 • *Hard Rock's Location Selection* 345 • *Rapid Review* 346 • *Self-Test* 348

## 9 Layout Strategies 349

- The Strategic Importance of Layout Decisions 350
- Types of Layout 351
- Office Layout 352
- Retail Layout 353
  - Servicescapes* 355
- Warehousing and Storage Layouts 356
  - Cross-Docking* 356
  - Random Stocking* 357
  - Customizing* 358
- Fixed-Position Layout 358
- Process-Oriented Layout 359
  - Computer Software for Process-Oriented Layouts* 363
- Work Cells 364
  - Requirements of Work Cells* 364
  - Staffing and Balancing Work Cells* 365
  - The Focused Work Centre and the Focused Factory* 367
- Repetitive and Product-Oriented Layout 367
  - Assembly-Line Balancing* 368
  - Chapter Summary* 373 • *Ethical Dilemma* 373 • *Discussion Questions* 373 • *Using Software to Solve Layout Problems* 373 • *Solved Problems* 374 • *Problems* 377 • *Case Studies: Automobile Licence Renewals* 382 • *Video Case Studies: Layout at Arnold Palmer Hospital* 383 • *Facility Layout at Wheeled Coach Ambulance* 384 • *Rapid Review* 385 • *Self-Test* 386

## 10 Human Resources, Job Design, and Work Measurement 387

- Human Resource Strategy for Competitive Advantage 389
  - Constraints on Human Resource Strategy* 389
- Labour Planning 390
  - Employment-Stability Policies* 390
  - Work Schedules* 390
  - Job Classifications and Work Rules* 391
- Job Design 391
  - Labour Specialization* 391
  - Job Expansion* 392
  - Psychological Components of Job Design* 392
  - Self-Directed Teams* 393
  - Motivation and Incentive Systems* 393
- Ergonomics and the Work Environment 395
  - Ergonomics* 395
  - Operator Input to Machines* 395
  - Feedback to Operators* 395
  - The Work Environment* 396

- Methods Analysis* 397
- The Visual Workplace* 399
- Labour Standards 400
  - Historical Experience* 400
  - Time Studies* 400
  - Predetermined Time Standards* 405
  - Work Sampling* 407
- Ethics 409
  - Chapter Summary* 410 • *Ethical Dilemma* 410 • *Discussion Questions* 410 • *Solved Problems* 411 • *Problems* 413 • *Case Studies: Jackson Manufacturing Company* 416 • *Video Case Studies: The “People” Focus: Human Resources at Alaska Airlines* 416 • *Human Resources at Hard Rock Cafe* 417 • *Rapid Review* 418 • *Self-Test* 420

## PART THREE Managing Operations 421

### 11 Supply Chain Management 421

- The Supply Chain’s Strategic Importance 422
  - Supply Chain Risk* 424
- Ethics and Sustainability 425
  - Personal Ethics* 425
  - Ethics within the Supply Chain* 425
  - Ethical Behaviour Regarding the Environment* 425
- Supply Chain Economics 426
  - Make-or-Buy Decisions* 427
  - Outsourcing* 427
- Supply Chain Strategies 427
  - Many Suppliers* 428
  - Few Suppliers* 428
  - Vertical Integration* 428
  - Joint Ventures* 429
  - Keiretsu Networks* 429
  - Virtual Companies* 429
- Managing the Supply Chain 430
  - Mutual Agreement on Goals* 430
  - Trust* 430
  - Compatible Organizational Cultures* 430
  - Issues in an Integrated Supply Chain* 431
  - Opportunities in an Integrated Supply Chain* 431
- Eprocurement 433
  - Electronic Ordering and Funds Transfer* 434
  - Online Catalogues* 434
  - Auctions* 434

RFQs	434
Real-Time Inventory Tracking	434
Vendor Selection	435
Vendor Evaluation	435
Vendor Development	436
Negotiations	436
Contracting	437
Centralized Purchasing	437
E-Procurement	437
Logistics Management	438
Distribution Systems	438
Warehousing	439
Third-Party Logistics	440
Cost of Shipping Alternatives	440
Security and JIT	441
Measuring Supply Chain Performance	442
Supply Chain Performance	442
Assets Committed to Inventory	442
The SCOR Model	444
Chapter Summary	445 • Ethical Dilemma 445 • Discussion Questions 445 • Solved Problems 445 • Problems 446 • Case Studies: Dell's Value Chain 447 • Video Case Studies: Darden's Global Supply Chain 448 • Supply Chain Management at Regal Marine 449 • Arnold Palmer Hospital's Supply Chain 449 • Rapid Review 450 • Self-Test 452

## 11 Supplement: Supply Chain Management Analytics 453

Techniques for Evaluating Supply Chains	453
Evaluating Disaster Risk in the Supply Chain	453
Managing the Bullwhip Effect	455
A Bullwhip Effect Measure	456
Supplier Selection Analysis	457
Transportation Mode Analysis	458
Warehouse Storage	459
Supplement Summary	460 • Discussion Questions 460 • Solved Problems 460 • Problems 462 • Rapid Review 465 • Self-Test 467

## 12 Inventory Management 468

The Importance of Inventory	470
Functions of Inventory	471
Types of Inventory	471
Managing Inventory	472
ABC Analysis	472
Record Accuracy	474
Cycle Counting	474
Control of Service Inventories	476
Inventory Models	478

Independent versus Dependent Demand	478
Holding, Ordering, and Setup Costs	478
Inventory Models for Independent Demand	478
The Basic Economic Order Quantity (EOQ) Model	479
Minimizing Costs	479
Reorder Points	483
Production Order Quantity Model	485
Quantity Discount Models	487
Probabilistic Models and Safety Stock	490
Other Probabilistic Models	493
Single-Period Model	495
Fixed-Period (P) Systems	496
Chapter Summary	497 • Ethical Dilemma 497 • Discussion Questions 497 • Using Software to Solve Inventory Problems 498 • Solved Problem 499 • Problems 502 • Case Studies: Zhou Bicycle Company 507 • Video Case Studies: Managing Inventory at Frito-Lay 507 • Inventory Control at Wheeled Coach Ambulance 508 • Rapid Review 508 • Self-Test 510

## 13 Aggregate Planning and Sales and Operations Planning 512

The Planning Process	513
Sales and Operations Planning	513
The Nature of Aggregate Planning	515
Aggregate Planning Strategies	516
Capacity Options	517
Demand Options	517
Mixing Options to Develop a Plan	518
Methods for Aggregate Planning	519
Graphical Methods	519
Mathematical Approaches	523
Comparison of Aggregate Planning Methods	525
Aggregate Planning in Services	526
Restaurants	526
Hospitals	527
National Chains of Small Service Firms	527
Miscellaneous Services	527
Airline Industry	528
Yield Management	528
Chapter Summary	531 • Ethical Dilemma 531 • Discussion Questions 532 • Using Software for Aggregate Planning 532 • Solved Problems 533 • Problems 534 • Case Studies: Fast Creek Lightning (G) 538 • Andrew-Carter, Inc. 539 • Video Case Studies: Using Revenue Management to Set Orlando Magic Ticket Prices 540 • Rapid Review 540 • Self-Test 542

## 14 Material Requirements Planning (MRP) and ERP 543

- Dependent Demand 544
- Dependent Inventory Model Requirements 545
  - Master Production Schedule* 545
  - Bills of Material* 547
  - Accurate Inventory Records* 549
  - Purchase Orders Outstanding* 549
  - Lead Times for Components* 549
- MRP Structure 550
- MRP Management 554
  - MRP Dynamics* 554
  - MRP and JIT* 554
- Lot-Sizing Techniques 555
  - Lot-for-Lot* 555
  - Economic Order Quantity (EOQ)* 556
  - Periodic Order Quantity* 557
  - Lot-Sizing Summary* 558
- Extensions of MRP 559
  - Material Requirements Planning II (MRP II)* 559
  - Closed-Loop MRP* 560
  - Capacity Planning* 560
- MRP in Services 561
  - Restaurants* 562
  - Hospitals* 562
  - Hotels* 562
  - Distribution Resource Planning (DRP)* 563
- Enterprise Resource Planning (ERP) 563
  - ERP in the Service Sector* 565
  - Chapter Summary* 566 • *Ethical Dilemma* 566 • *Discussion Questions* 566 • *Using Software to Solve MRP Problems* 566 • *Solved Problems* 568 • *Problems* 571 • *Case Studies: Hill's Automotive, Inc.* 575 • *Video Case Studies: When 18 500 Orlando Magic Fans Come to Dinner* 575 • *MRP at Wheeled Coach Ambulance* 576 • *Rapid Review* 577 • *Self-Test* 579

## 15 Short-Term Scheduling 580

- The Importance of Short-Term Scheduling 581
- Scheduling Issues 582
  - Forward and Backward Scheduling* 583
  - Finite and Infinite Loading* 584
  - Scheduling Criteria* 585
- Scheduling Process-Focused Facilities 586
- Loading Jobs 586
  - Input-Output Control* 586
  - Gantt Charts* 588
  - Assignment Method* 588

- Sequencing Jobs 592
  - Priority Rules for Dispatching Jobs* 592
  - Critical Ratio* 595
  - Sequencing N Jobs on Two Machines: Johnson's Rule* 595
  - Limitations of Rule-Based Dispatching Systems* 597
- Finite Capacity Scheduling (FCS) 597
- Scheduling Repetitive Facilities 599
- Scheduling Services 599
  - Hospitals* 599
  - Banks* 599
  - Retail Stores* 600
  - Airlines* 600
  - 24/7 Operations* 600
  - Scheduling Service Employees with Cyclical Scheduling* 601
  - Cyclical Scheduling* 601
  - Chapter Summary* 603 • *Ethical Dilemma* 603 • *Discussion Questions* 603 • *Using Software for Short-Term Scheduling* 603 • *Solved Problems* 605 • *Problems* 608 • *Case Studies: Old Muskoka Wood Store* 611 • *Video Case Studies: From the Eagles to the Magic: Converting the Amway Center* 612 • *Scheduling at Hard Rock Cafe* 614 • *Rapid Review* 614 • *Self-Test* 616

## 16 Lean Operations 617

- Lean Operations 619
  - Eliminate Waste* 619
  - Remove Variability* 621
  - Improve Throughput* 621
- Lean and Just-in-Time 621
  - Supplier Partnerships* 621
- Lean Layout 624
  - Distance Reduction* 624
  - Increased Flexibility* 624
  - Impact on Employees* 624
  - Reduced Space and Inventory* 625
- Lean Inventory 625
  - Reduce Inventory and Variability* 625
  - Reduce Lot Sizes* 626
  - Reduce Setup Costs* 627
- Lean Scheduling 628
  - Level Schedules* 628
  - Kanban* 629
- Lean Quality 631
- Toyota Production System 632
  - Continuous Improvement* 632
  - Respect for People* 633
  - Processes and Standard Work Practice* 633

Lean Organizations	633
<i>Building a Lean Organization</i>	633
<i>Lean Sustainability</i>	634
Lean Operations in Services	635
<i>Suppliers</i>	635
<i>Layouts</i>	635
<i>Inventory</i>	635
<i>Scheduling</i>	635
<i>Chapter Summary</i>	635 • <i>Ethical Dilemma</i>
636 • <i>Discussion Questions</i>	636 • <i>Solved Problems</i>
636 • <i>Problems</i>	637 • <i>Case Studies:</i>
<i>Saskatchewan Mutual Insurance Company</i>	638 • <i>Video Case Studies: Lean Operations</i>
<i>at Alaska Airline</i>	638 • <i>JIT at Arnold</i>
<i>Palmer Hospital</i>	640 • <i>Rapid Review</i>
640 • <i>Self-Test</i>	642

## **17 Maintenance and Reliability** 643

The Strategic Importance of Maintenance and Reliability	644
Reliability	645
<i>Improving Individual Components</i>	645
<i>Providing Redundancy</i>	647
Maintenance	649
<i>Implementing Preventive Maintenance</i>	649
<i>Increasing Repair Capabilities</i>	652
<i>Autonomous Maintenance</i>	653
Total Productive Maintenance	653
Techniques for Enhancing Maintenance	653
<i>Simulation</i>	653
<i>Expert Systems</i>	654
<i>Automated Sensors</i>	654
<i>Chapter Summary</i>	654 • <i>Ethical Dilemma</i>
654 • <i>Discussion Questions</i>	654 • <i>Using Software to Solve Reliability Problems</i>
655 • <i>Solved Problems</i>	655 • <i>Problems</i>
655 • <i>Video Case Study: Maintenance Drives Profits at Frito-Lay</i>	657 • <i>Rapid Review</i>
658 • <i>Self-Test</i>	659

## **PART FOUR** **Business Analytics** **Modules 661**

### **A Decision-Making Tools** 661

The Decision Process in Operations	661
Fundamentals of Decision Making	662
Decision Tables	663
Types of Decision-Making Environments	664
<i>Decision Making Under Uncertainty</i>	664

<i>Decision Making Under Risk</i>	665
<i>Decision Making Under Certainty</i>	665
<i>Expected Value of Perfect Information (EVPI)</i>	666
Decision Trees	667
<i>A More Complex Decision Tree</i>	668
Using Decision Trees in Ethical Decision Making	670
<i>The Poker Decision Process</i>	671
<i>Module Summary</i>	671 • <i>Discussion Questions</i>
671 • <i>Using Software for Decision Models</i>	672 • <i>Solved Problems</i>
673 • <i>Problems</i>	674 • <i>Case Study: Tom Tucker's Liver Transplant</i>
678 • <i>Rapid Review</i>	678 • <i>Self-Test</i>
680	

### **B Linear Programming** 681

Why Use Linear Programming?	681
Requirements of a Linear Programming Problem	682
Formulating Linear Programming Problems	682
<i>Glickman Electronics Example</i>	682
Graphical Solution to a Linear Programming Problem	683
<i>Graphical Representation of Constraints</i>	683
<i>Iso-Profit Line Solution Method</i>	684
<i>Corner-Point Solution Method</i>	687
Sensitivity Analysis	688
<i>Sensitivity Report</i>	689
<i>Changes in the Resources or Right-Hand-Side Values</i>	689
<i>Changes in the Objective Function Coefficient</i>	690
Solving Minimization Problems	690
Linear Programming Applications	692
<i>Production-Mix Example</i>	692
<i>Diet Problem Example</i>	693
<i>Labour Scheduling Example</i>	694
The Simplex Method of LP	695
Integer and Binary Variables	696
<i>Creating Integer and Binary Variables</i>	696
<i>Linear Programming Applications with Binary Variables</i>	696
<i>A Fixed-Charge Integer Programming Problem</i>	697
<i>Module Summary</i>	698 • <i>Discussion Questions</i>
698 • <i>Using Software to Solve LP Problems</i>	699 • <i>Solved Problems</i>
700 • <i>Problems</i>	702 • <i>Case Study: Golding Landscaping and Plants Inc.</i>
708 • <i>Rapid Review</i>	708
• <i>Self-Test</i>	710

**C Transportation Models 711**

- Transportation Modelling 711
- Developing an Initial Solution 713
  - The Northwest-Corner Rule* 713
  - The Intuitive Lowest-Cost Method* 714
- The Stepping-Stone Method 715
- Special Issues in Modelling 718
  - Demand Not Equal to Supply* 718
  - Degeneracy* 719
  - Module Summary* 720 • *Discussion Questions* 720 • *Using Software to Solve Transportation Problems* 721 • *Solved Problems* 722 • *Problems* 724 • *Case Study: Custom Vans Inc.* 727
  - *Rapid Review* 728 • *Self-Test* 730

**D Waiting-Line Models 731**

- Queuing Theory 731
- Characteristics of a Waiting-Line System 732
  - Arrival Characteristics* 732
  - Waiting-Line Characteristics* 734
  - Service Characteristics* 734
  - Measuring a Queue's Performance* 736
- Queuing Costs 736
- The Variety of Queuing Models 737
  - Model A (M/M/1): Single-Channel Queuing Model with Poisson Arrivals and Exponential Service Times* 738
  - Model B (M/M/S): Multiple-Channel Queuing Model* 741
  - Model C (M/D/1): Constant-Service-Time Model* 745
  - Little's Law* 746
  - Model D: Limited-Population Model* 746
- Other Queuing Approaches 749
  - Module Summary* 750 • *Discussion Questions* 750 • *Using Software to Solve Queuing Problems* 750 • *Solved Problems* 751 • *Problems* 753 • *Case Studies: Labrador Foundry Inc.* 756 • *The Winter Park Hotel* 757 • *Rapid Review* 758
  - *Self-Test* 759

**E Learning Curves 761**

- What Is a Learning Curve? 761
- Learning Curves in Services and Manufacturing 762
- Applying the Learning Curve 763
  - Arithmetic Approach* 763
  - Logarithmic Approach* 763
  - Learning-Curve Coefficient Approach* 764
- Strategic Implications of Learning Curves 766

- Limitations of Learning Curves 767
  - Module Summary* 767 • *Discussion Questions* 767 • *Using Software for Learning Curves* 767 • *Solved Problems* 768 • *Problems* 769 • *Case Study: SMT's Negotiation with IBM* 771 • *Rapid Review* 772 • *Self-Test* 774

**F Simulation 775**

- What Is Simulation? 775
- Advantages and Disadvantages of Simulation 776
- Monte Carlo Simulation 777
  - Step 1. Establishing Probability Distributions* 777
  - Step 2. Building a Cumulative Probability Distribution for Each Variable* 778
  - Step 3. Setting Random-Number Intervals* 778
  - Step 4. Generating Random Numbers* 779
  - Step 5. Simulating the Experiment* 779
- Simulation of a Queuing Problem 780
- Simulation and Inventory Analysis 783
  - Module Summary* 786 • *Discussion Questions* 786 • *Using Software in Simulation* 786
  - *Solved Problems* 788 • *Problems* 789 • *Case Study: Canadian Shield Airlines Call Centre* 793 • *Rapid Review* 794 • *Self-Test* 796

- Appendix A1
- Bibliography B1
- Indices I1

**Online Tutorials****1 Statistical Tools for Managers T1-1**

- Discrete Probability Distributions T1-2
  - Expected Value of a Discrete Probability Distribution* T1-3
  - Variance of a Discrete Probability Distribution* T1-3
- Continuous Probability Distributions T1-4
  - The Normal Distribution* T1-4
  - Summary* T1-7 • *Key Terms* T1-7 • *Discussion Questions* T1-7 • *Problems* T1-7
  - *Bibliography* T1-8

**2 Acceptance Sampling T2-1**

- Sampling Plans T2-2
  - Single Sampling* T2-2
  - Double Sampling* T2-2
  - Sequential Sampling* T2-2

Operating Characteristic (OC) Curves T2-2  
 Producer's and Consumer's Risk T2-3  
 Average Outgoing Quality T2-5  
*Summary T2-6 • Key Terms T2-6 • Solved  
 Problem T2-7 • Discussion Questions T2-7  
 • Problems T2-7*

### **3 The Simplex Method of Linear Programming T3-1**

Converting the Constraints to Equations T3-2  
 Setting Up the First Simplex Tableau T3-2  
 Simplex Solution Procedures T3-4  
 Summary of Simplex Steps for Maximization Problems T3-6  
 Artificial and Surplus Variables T3-7  
 Solving Minimization Problems T3-7  
*Summary T3-8 • Key Terms T3-8 • Solved  
 Problem T3-8 • Discussion Questions T3-8  
 • Problems T3-9*

### **4 The MODI and VAM Methods of Solving Transportation Problems T4-1**

MODI Method T4-2  
*How to Use the MODI Method T4-2  
 Solving the Arizona Plumbing Problem with  
 MODI T4-2*

Vogel's Approximation Method: Another Way to Find an Initial Solution T4-4  
*Discussion Questions T4-8 • Problems T4-8*

### **5 Vehicle Routing and Scheduling T5-1**

Introduction T5-2  
*Service Delivery Example: Meals-for-ME T5-2*  
 Objectives of Routing and Scheduling Problems T5-2  
 Characteristics of Routing and Scheduling Problems T5-3  
*Classifying Routing and Scheduling Problems T5-3  
 Solving Routing and Scheduling Problems T5-4*  
 Routing Service Vehicles T5-5  
*The Traveling Salesman Problem T5-5  
 Multiple Traveling Salesman Problem T5-8  
 The Vehicle Routing Problem T5-9  
 Cluster First, Route Second Approach T5-10*  
 Scheduling Service Vehicles T5-11  
*The Concurrent Scheduler Approach T5-13*  
 Other Routing and Scheduling Problems T5-13  
*Summary T5-14 • Key Terms T5-15 • Discussion Questions T5-15 • Problems T5-15 • Case Study: Routing and Scheduling of Phlebotomists T5-17 • Bibliography T5-17*

# Preface

Welcome to your operations management (OM) course and to the third Canadian edition of this textbook. This text presents a state-of-the-art view of the activities of the operations function from a Canadian perspective. Operations is an exciting and dynamic area of management that has a profound effect on the productivity of both services and manufacturing. Indeed, few other activities have so much impact on the quality of your life. The goal of this book is to present a broad introduction to the field of operations in a realistic, meaningful, and practical manner. OM includes a blend of subject areas, including accounting, industrial engineering, management, management science, and statistics. Whether you are pursuing a career in the operations field or not, you will likely be working with people in operations. Therefore, having a solid understanding of the role of operations in an organization is of substantial benefit to you. This text will also help you understand how OM affects society and your life. Certainly, you will better understand what goes on behind the scenes when you buy a coffee at Tim Hortons, take a flight from Edmonton to Vancouver, place an order with Amazon.ca, or enter a Canadian hospital for medical care.

Although many readers of this book are not OM majors, students studying marketing, finance, accounting, and MIS will hopefully find the material both interesting and useful as they develop a fundamental working knowledge of the operations side of the firm.

## ABOUT THE THIRD CANADIAN EDITION

The goal of this third Canadian edition is to retain the features and strengths that have made this book so successful over the years while bringing a new Canadian perspective to the text. Readers will find examples of Canadian companies and success stories woven throughout the book with cases drawn from the manufacturing and service industry taken from both the private and public sectors. The text describes many Canadian locations and uses Canadian data when available. Readers can follow the story of the construction of a hockey arena as a recurring case study that touches upon many aspects of OM in a familiar setting. It is also important to acknowledge the global nature of today's business environment. Operations management is a discipline that encompasses both the local and the international, with global considerations affecting everything from location strategies to scheduling and transportation. This third Canadian edition therefore retains many of the best and most familiar U.S. and international examples.

## NEW TO THIS EDITION

We've made significant revisions to this edition, and we want to share some of the changes with you.

**Five New Video Case Studies Featuring Alaska Airlines** In this edition we take you behind the scenes of Alaska Airlines, consistently rated as one of the top carriers in North America. This fascinating organization opened its doors—and planes—so we could examine leading-edge OM in the airline industry. We observe the quality program at Alaska Air (Chapter 6), the process analysis behind the airline's 20-minute baggage retrieval guarantee (Chapter 7), how Alaska empowers its employees (Chapter 10), the airline's use of Lean, 5s, kaizen, and Gemba walks (Chapter 16), and the complexities of scheduling (Module B). These videos, and other video case studies that feature real companies, can be found in MyLab Operations Management.

**New Sustainability in the Supply Chain Supplement 5** We have enhanced the coverage of sustainability in this edition with the inclusion of a brand-new supplement that covers the topics of corporate social responsibility, design and production for sustainability, and regulations and industry standards.

**Creating Your Own Excel Spreadsheets** We continue to provide two free decision support software programs, Excel OM for Windows and Mac and POM for Windows, to help

you and your students solve homework problems and case studies. These excellent packages are found in MyLab Operations Management's Download Center.

Many instructors also encourage students to develop their own Excel spreadsheet models to tackle OM issues. With this edition we provide numerous examples at chapter end on how to do so. "Creating Your Own Excel Spreadsheets" examples now appear in Chapters 2, 4, 8, 12, and Supplement 6, Supplement 7, and Modules A, and F. We hope these 8 samples will help expand students' spreadsheet capabilities.

**Expanding and Reordering Our Set of Homework Problems** We believe that a vast selection of quality homework problems, ranging from easy to challenging (denoted by one to four dots), is critical for both instructors and students. Instructors need a broad selection of problems to choose from for homework, quizzes, and exams—without reusing the same set from semester to semester. We take pride in having more problems than any other OM text. We added dozens of new problems this edition.

Further, with the majority of our adopters now using the MyLab Operations Management learning system in their classes, we have reorganized all the homework problems—both those appearing in the printed text and the additional homework problems that are available in MyLab Operations Management—by topic heading. We identify all problems by topic.

The list of all problems by topic also appears at the end of each boxed example as well as in the Rapid Review that closes each chapter. These handy references should make it easier to assign problems for homework, quizzes, and exams. A rich set of assignable problems and cases makes the learning experience more complete and pedagogically sound.

**Lean Operations** In previous editions we sought to explicitly differentiate the concepts of just-in-time, Lean, and the Toyota Production System in Chapter 16. However, there is significant overlap and interchangeability among those three concepts, so we have revised Chapter 16 to incorporate the three concepts into an overall concept of "Lean". The chapter suggests that students view Lean as a comprehensive integrated operations strategy that sustains competitive advantage and results in increased returns to all stakeholders.

In addition, the following changes have been made for the third Canadian edition:

- New section on strategic planning, core competencies, and outsourcing added to Chapter 2.
- Coverage of agile and waterfall approaches to project management have been revised in Chapter 3.
- New section on supply chain management in Chapter 4.
- Added coverage of sustainability and life cycle assessment (LCA) to Chapter 5.
- New section on ISO 9000 International Quality Standards in Chapter 6.
- Coverage of bottleneck analysis in Supplement 7 has been completely revised.
- Added coverage of supplier certification, contracting, and centralized purchasing to Chapter 11.
- Added section on warehouse storage to Supplement 11.
- Coverage of economic order quantity enhanced with new section on period order quantity in Chapter 14.
- Added coverage of finite and infinite loading to Chapter 15.
- Added coverage of Lean sustainability to Chapter 16.
- Added coverage of parallel redundancy to Chapter 17.
- New examples and case studies throughout the text.

**MyLab Operations Management Resources** In addition to our video case studies and our Excel OM and POM for Windows software, we provide the following resources in MyLab Operations Management:

- Excel OM data files: Prepared for specific examples, these files allow users to solve all the marked text examples without reentering data.
- Active Models: These are Excel-based OM simulations, designed to help students understand the quantitative methods shown in the textbook examples. Students may change the

data to see how the changes affect the answers. These files are available in the Download Center.

- Online Tutorial Chapters: “Statistical Tools for Managers,” “Acceptance Sampling,” “The Simplex Method of Linear Programming,” “The MODI and VAM Methods of Solving Transportation Problems,” and “Vehicle Routing and Scheduling” are provided as additional material.
- Additional case studies: These case studies supplement the ones in the text.
- Virtual office hours videos: Professors Heizer, Render, and Munson walk students through the Solved Problems in a series of 5- to 20-minute explanations.

## ACKNOWLEDGMENTS

We wish to acknowledge the contributions of the following reviewers who provided feedback during the development of the manuscript.

Farid Albehadili,  
*University of Prince Edward Island*

Elkafi Hassini,  
*McMaster University*

Gary Llewellyn Evans,  
*University of Prince Edward Island*

Sam Lampropoulos,  
*George Brown College*

Scott Hadley,  
*Sheridan College*

David Roberts,  
*Southern Alberta Institute of Technology*

Publishing a textbook requires the work of many talented individuals to handle the specialized tasks of development, photography, graphic design, illustration, editing, and production, to name only a few. I would like to thank Scott Hardie, Portfolio Manager; and Jennifer Murray, Content Developer, for her editorial guidance throughout the writing stage. I also thank the rest of the talented team: John Polanszky, Content Manager; Pippa Kennard and Christine Selvan, Project Managers; Sally Glover, Copy Editor; the team at Pearson CSC, and, finally, Spencer Snell, Marketing Manager.

But most of all, I thank my wife, Suzanne, and my children, Alexandra and Kathleen; my granddaughter, Kenna; plus Ryan and Robert, family and extended family, friends, and colleagues. I couldn't have done it without all of their support.

# 1

## Learning Objectives

- LO1** Define *operations management* 2
- LO2** Explain the distinction between goods and services 9
- LO3** Explain the difference between production and productivity 11
- LO4** Compute single-factor productivity 12
- LO5** Compute multifactor productivity 13
- LO6** Identify the critical variables in enhancing productivity 14

# Operations and Productivity

## Operations Management at Hard Rock Cafe

Operations managers throughout the world are producing products daily to provide for the well-being of society. These products take on a multitude of forms, including auto parts at Magna International, motion pictures at DreamWorks Studios, rides at Disney World, and food at Hard Rock Cafe. These firms produce thousands of complex products every day—to be delivered as the customer ordered them, when the customer wants them, and where the customer wants them. Hard Rock does this for over 35 million guests worldwide every year. This is a challenging task, and the operations manager’s job—whether at Magna International, DreamWorks, Disney, or Hard Rock—is demanding.

Orlando-based Hard Rock Cafe opened its first restaurant in London in 1971, making it over four decades old and the granddaddy of theme restaurants. Although other theme restaurants have come and gone, Hard Rock is still going strong, with 150 restaurants in 53 countries—and new restaurants opening each year. Hard Rock made its name with rock music memorabilia, having started when Eric Clapton, a regular customer, marked his favourite bar stool by hanging his guitar on the wall in the London cafe. Now Hard

◀ **Global Company Profile**  
**Hard Rock Cafe**

Rock has 70 000 items and millions of dollars invested in memorabilia. To keep customers coming back time and again, Hard Rock creates value in the form of good food and entertainment.

The operations managers at Hard Rock Cafe at Universal Studios in Orlando provide more than 3500 custom products—in this case, meals—every day. These products are designed, tested, and then analyzed for cost of ingredients, labour requirements, and customer satisfaction. On approval, menu items are put into production—and then only if the ingredients are available from qualified suppliers. The production process—from receiving, to cold storage, to grilling or baking or frying, and a dozen other steps—is designed and maintained to yield a quality meal. Operations managers, using the best people they can recruit and train, also prepare effective employee schedules and design efficient layouts.

Managers who successfully design and deliver goods and services throughout the world understand operations. In this textbook, we look not only at how



Andre Jemmy/Alamy Stock Photo

Hard Rock Cafe in Orlando, Florida, prepares over 3500 meals each day. Seating more than 1500 people, it is one of the largest restaurants in the world. But Hard Rock's operations managers serve the hot food hot and the cold food cold.

Hard Rock's managers create value but also at how operations managers in other services, as well as in manufacturing, do so. Operations management is demanding, challenging, and exciting. It affects our lives every day. Ultimately, operations managers determine how well we live.

**STUDENT TIP**

Operations management is one of the three functions that every organization performs.

**LO1** Define operations management

**VIDEO 1.1**

Operations Management at Hard Rock

**VIDEO 1.2**

Operations Management at Frito-Lay

**Production**

The creation of goods and services.

**Operations management (OM)**

Activities that relate to the creation of goods and services through the transformation of inputs to outputs.

## What Is Operations Management?

Operations management (OM) is a discipline that applies to restaurants like Hard Rock Cafe as well as to factories like Ford and Whirlpool. The techniques of OM apply throughout the world to virtually all productive enterprises. It doesn't matter if the application is in an office, a hospital, a restaurant, a department store, or a factory—the production of goods and services requires operations management. And the *efficient* production of goods and services requires effective application of the concepts, tools, and techniques of OM that we introduce in this book.

As we progress through this text, we will discover how to manage operations in a changing global economy. An array of informative examples, charts, text discussions, and pictures illustrate concepts and provide information. We will see how operations managers create the goods and services that enrich our lives.

In this chapter, we first define *operations management*, explaining its heritage and exploring the exciting role operations managers play in a huge variety of organizations. Then we discuss production and productivity in both goods- and service-producing firms. This is followed by a discussion of operations in the service sector and the challenge of managing an effective and efficient production system.

**Production** is the creation of goods and services. **Operations management (OM)** is the set of activities that creates value in the form of goods and services by transforming inputs into outputs. Activities creating goods and services take place in all organizations. In manufacturing firms, the production activities that create goods are usually quite obvious. In them, we can see the creation of a tangible product such as a Sony TV or a Harley-Davidson motorcycle.

In an organization that does not create a tangible good or product, the production function may be less obvious. We often call these activities *services*. The services may be “hidden” from the public and even from the customer. The product may take such forms as the transfer of funds from a savings account to a chequing account, the transplant of a human organ, the filling of an empty seat on an airplane, or the education of a student. Regardless of whether the end product is a good or service, the production activities that go on in the organization are often referred to as operations, or *operations management*.

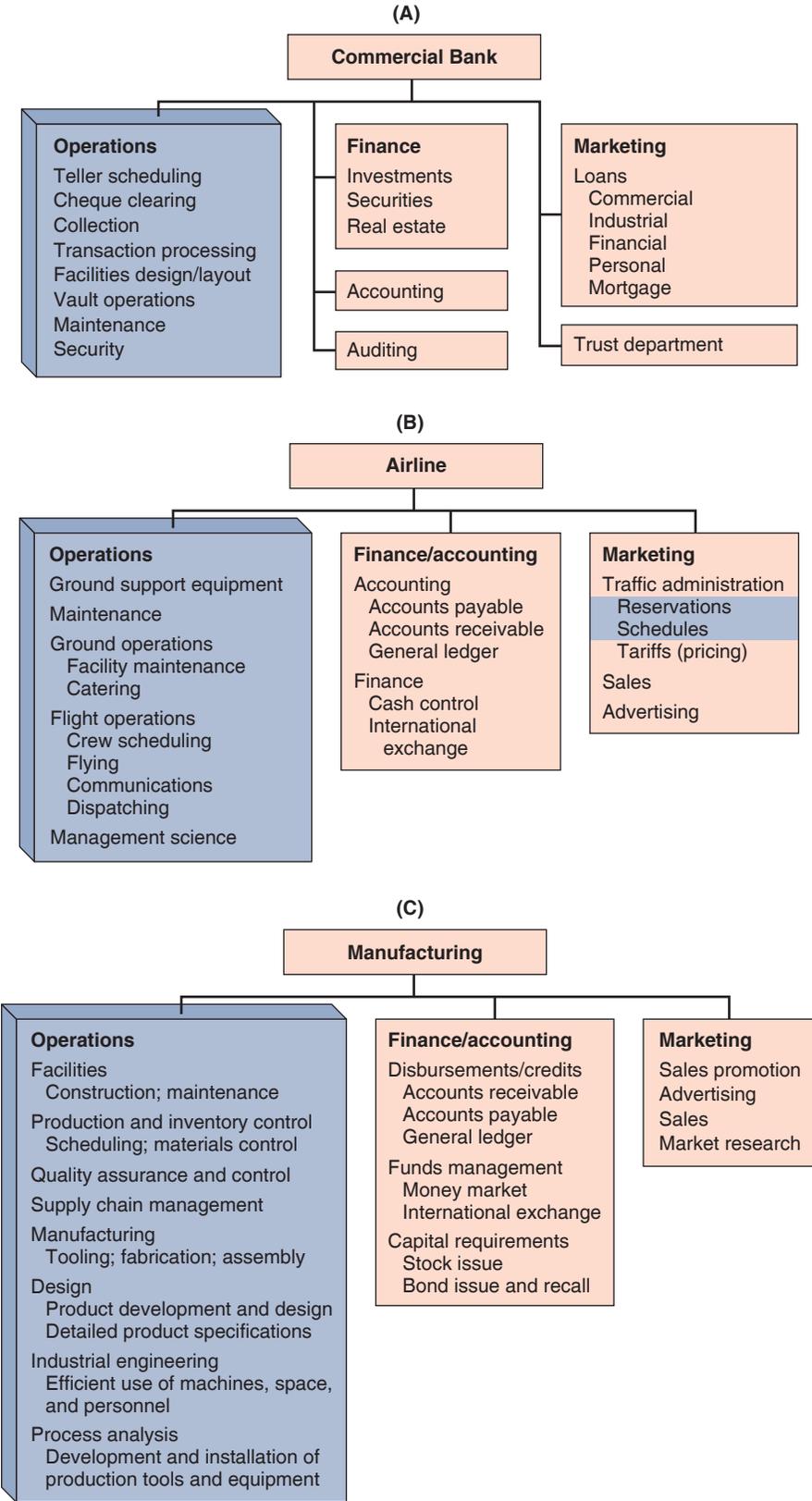
# Organizing to Produce Goods and Services

**STUDENT TIP**

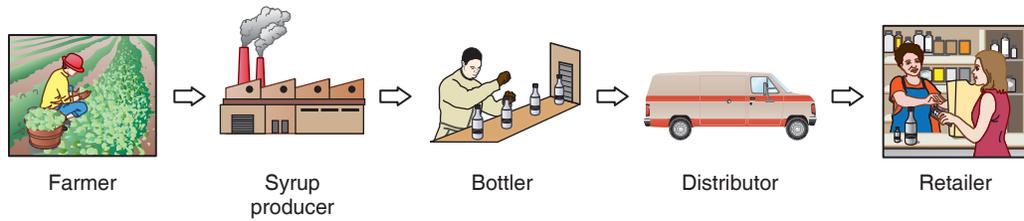
Let's begin by defining what this course is about.

To create goods and services, all organizations perform three functions (see Figure 1.1). These functions are the necessary ingredients not only for production but also for an organization's survival. They are:

1. *Marketing*, which generates the demand, or at least takes the order for a product or service (nothing happens until there is a sale).



**FIGURE 1.1**  
**Organization Charts for Two Service Organizations and One Manufacturing Organization**  
 (A) A bank, (B) an airline, and (C) a manufacturing organization. The blue areas are OM activities.



**FIGURE 1.2** Soft Drink Supply Chain

A supply chain for a bottle of Coke requires a beet or sugar cane farmer, a syrup producer, a bottler, a distributor, and a retailer, each adding value to satisfy a customer. Only with collaborations between all members of the supply chain can efficiency and customer satisfaction be maximized. The supply chain, in general, starts with the provider of basic raw materials and continues all the way to the final customer at the retail store.

2. *Production/operations*, which creates, produces, and delivers the product.
3. *Finance/accounting*, which tracks how well the organization is doing, pays the bills, and collects the money.

Universities, places of worship, and businesses all perform these functions. Even a volunteer group such as Scouts Canada is organized to perform these three basic functions. Figure 1.1 shows how a bank, an airline, and a manufacturing firm organize themselves to perform these functions. The blue-shaded areas of Figure 1.1 show the operations functions in these firms.

## THE SUPPLY CHAIN

Through the three functions—marketing, operations, and finance—value for the customer is created. However, firms seldom create this value by themselves. Instead, they rely on a variety of suppliers who provide everything from raw materials to accounting services. These suppliers, when taken together, can be thought of as a supply chain. A **supply chain** (see Figure 1.2) is a global network of organizations and activities that supply a firm with goods and services.

As our society becomes more technologically oriented, we see increasing specialization. Specialized expert knowledge, instant communication, and cheaper transportation also foster specialization and worldwide supply chains. It just does not pay for a firm to try to do everything itself. The expertise that comes with specialization exists up and down the supply chain, adding value at each step. When members of the supply chain collaborate to achieve high levels of customer satisfaction, we have a tremendous force for efficiency and competitive advantage. Competition in the 21st century is no longer between companies; it is between supply chains.

### Supply chain

A global network of organizations and activities that supplies a firm with goods and services.

### STUDENT TIP

Good operations managers are scarce, and as a result, career opportunities and pay are excellent.

## Why Study Operations Management?

We study OM for four reasons:

1. OM is one of the three major functions of any organization, and it is integrally related to all the other business functions. All organizations market (sell), finance (account), and produce (operate), and it is important to know how the OM activity functions. Therefore, we study *how people organize themselves for productive enterprise*.
2. We study OM because we want to know *how goods and services are produced*. The production function is the segment of our society that creates the products and services we use.
3. We study OM to *understand what operations managers do*. Regardless of your job in an organization, you can perform better if you understand what operations managers do. In addition, understanding OM will help you explore the numerous and lucrative career opportunities in the field.
4. We study OM *because it is such a costly part of an organization*. A large percentage of the revenue of most firms is spent in the OM function. Indeed, OM provides a major opportunity for an organization to improve its profitability and enhance its service to society. Example 1 considers how a firm might increase its profitability via the production function.

Fisher Technologies is a small firm that must double its dollar contribution to fixed cost and profit in order to be profitable enough to purchase the next generation of production equipment. Management has determined that if the firm fails to increase its contribution, its bank will not make the loan and the equipment cannot be purchased. If the firm cannot purchase the equipment, the limitations of the old equipment will force Fisher to go out of business and, in doing so, put its employees out of work and discontinue producing goods and services for its customers.

**APPROACH** ▶ Table 1.1 shows a simple profit-and-loss statement and three strategic options (marketing, finance/accounting, and operations) for the firm. The first option is a *marketing option*, where good marketing management may increase sales by 50%. By increasing sales by 50%, contribution will in turn increase 71%. But increasing sales 50% may be difficult; it may even be impossible.

		<i>Marketing Option<sup>a</sup></i>	<i>Finance/ Accounting Option<sup>b</sup></i>	<i>OM Option<sup>c</sup></i>
	<b>Current</b>	<b>Increase Sales Revenue 50%</b>	<b>Reduce Finance Costs 50%</b>	<b>Reduce Production Costs 20%</b>
Sales	\$100 000	\$ 150 000	\$100 000	\$100 000
Costs of goods	<u>−80 000</u>	<u>−120 000</u>	<u>−80 000</u>	<u>−64 000</u>
Gross margin	20 000	30 000	20 000	36 000
Finance costs	<u>−6 000</u>	<u>−6 000</u>	<u>−3 000</u>	<u>−6 000</u>
Subtotal	14 000	24 000	17 000	30 000
Taxes at 25%	<u>−3 500</u>	<u>−6 000</u>	<u>−4 250</u>	<u>−7 500</u>
Contribution <sup>d</sup>	\$ 10 500	\$ 18 000	\$ 12 750	\$ 22 500

<sup>a</sup> Increasing sales 50% increases contribution by \$7500, or 71% (= 7500/10 500).  
<sup>b</sup> Reducing finance costs 50% increases contribution by \$2250, or 21% (= 2250/10 500).  
<sup>c</sup> Reducing production costs 20% increases contribution by \$12 000, or 114% (= 12 000/10 500).  
<sup>d</sup> Contribution to fixed costs (excluding finance costs) and profit.

**EXAMPLE 1****Examining the Options for Increasing Contribution****Table 1.1**  
Options for Increasing Contribution

The second option is a *finance/accounting option*, where finance costs are cut in half through good financial management. But even a reduction of 50% is still inadequate for generating the necessary increase in contribution. Contribution is increased by only 21%.

The third option is an *OM option*, where management reduces production costs by 20% and increases contribution by 114%.

**SOLUTION** ▶ Given the conditions of our brief example, Fisher Technologies has increased contribution from \$10 500 to \$22 500. It may now have a bank willing to lend it additional funds.

**INSIGHT** ▶ The OM option not only yields the greatest improvement in contribution but also may be the only feasible option. Increasing sales by 50% and decreasing finance costs by 50% may both be virtually impossible. Reducing operations costs by 20% may be difficult but feasible.

**LEARNING EXERCISE** ▶ What is the impact of only a 15% decrease in costs in the OM option? [Answer: A \$19 500 contribution; approximately an 86% increase.]

Example 1 underscores the importance of an effective operations activity of a firm. Development of increasingly effective operations is the approach taken by many companies as they face growing global competition.

## What Operations Managers Do

All good managers perform the basic functions of the management process. The **management process** consists of *planning, organizing, staffing, leading, and controlling*. Operations managers apply this management process to the decisions they make in the OM function. The 10 major decisions of OM are shown in Table 1.2. Successfully addressing each of these decisions requires planning, organizing, staffing, leading, and controlling. Typical issues relevant to these decisions and the chapter in which each is discussed are also shown.

**STUDENT TIP**

An operations manager must successfully address the 10 decisions around which this text is organized.

**Management process**

The application of planning, organizing, staffing, leading, and controlling to the achievement of objectives.

**Table 1.2**  
10 Critical Decisions  
of Operations Management

10 Decision Areas	Issues	Chapter(s)
1. Design of goods and services	What good or service should we offer? How should we design these products?	5
2. Managing quality	How do we define the quality? Who is responsible for quality?	6, Supplement 6
3. Process and capacity design	What process and what capacity will these products require? What equipment and technology are necessary for these processes?	7, Supplement 7
4. Location strategy	Where should we put the facility? On what criteria should we base the location decision?	8
5. Layout strategy	How should we arrange the facility? How large must the facility be to meet our plan?	9
6. Human resources and job design	How do we provide a reasonable work environment? How much can we expect our employees to produce?	10
7. Supply chain management	Should we make or buy this component? Who should be our suppliers, and how can we integrate them into our strategy?	11, Supplement 11
8. Inventory, material requirements planning, and JIT (just-in-time)	How much inventory of each item should we have? When do we reorder?	12, 14, 16
9. Intermediate and short-term scheduling	Are we better off keeping people on the payroll during slowdowns? Which job do we perform next?	13, 15
10. Maintenance	Who is responsible for maintenance?	17

**STUDENT TIP**

Current OM emphasis on quality and supply chain has increased job opportunities in these 10 areas.

## WHERE ARE THE OM JOBS?

How does one get started on a career in operations? The 10 OM decisions identified in Table 1.2 are made by individuals who work in the disciplines shown in the blue areas of Figure 1.1. Competent business students who know their accounting, statistics, finance, and OM have an opportunity to assume entry-level positions in all of these areas. As you read this text, identify disciplines that can assist you in making these decisions, then take courses in those areas. The more background an OM student has in accounting, statistics, information systems, and mathematics, the more job opportunities will be available. About 40% of all jobs are in OM.

The following professional organizations provide various certifications that may enhance your education and be of help in your career:

- APICS, the Association for Operations Management ([www.apics.org](http://www.apics.org))
- Standards Council of Canada ([www.scc.ca](http://www.scc.ca))
- Institute for Supply Management (ISM) ([www.instituteforsupplymanagement.org](http://www.instituteforsupplymanagement.org))
- Project Management Institute (PMI) ([www.pmi.org](http://www.pmi.org))
- Council of Supply Chain Management Professionals ([www.cscmp.org](http://www.cscmp.org))

Figure 1.3 shows some possible job opportunities.

## The Heritage of Operations Management

The field of OM is relatively young, but its history is rich and interesting. Our lives and the OM discipline have been enhanced by the innovations and contributions of numerous individuals. We now introduce a few of these people, and we provide a summary of significant events in operations management in Figure 1.4.

Eli Whitney (1800) is credited for the early popularization of interchangeable parts, which was achieved through standardization and quality control. Through a contract he signed with the

Operations Management Positions

SEARCH JOBS

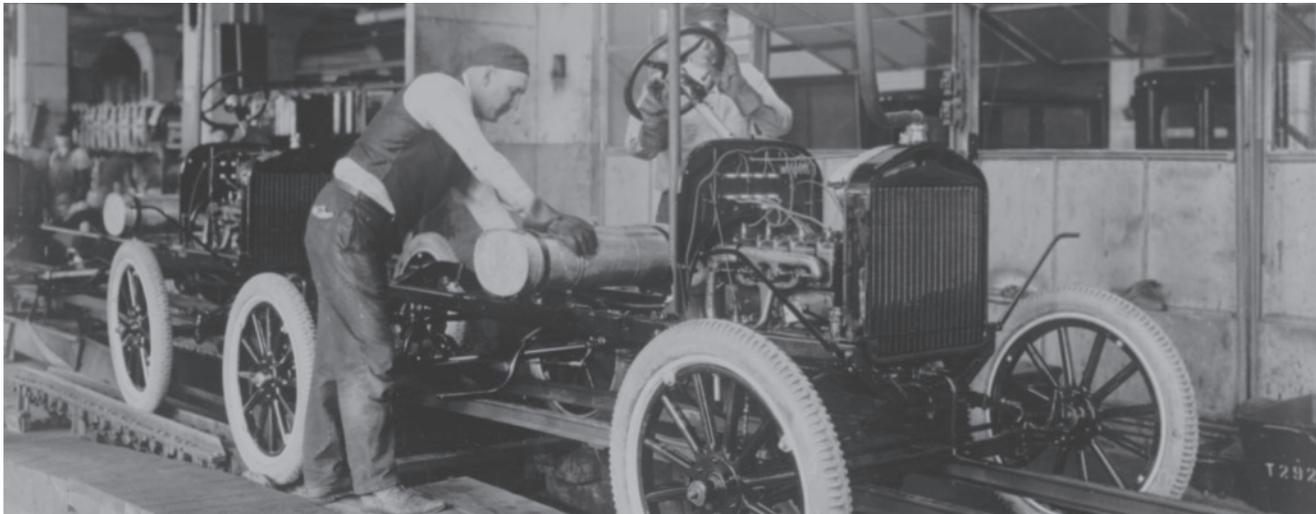
▼ Date    ▼ Job Title

1/15	<p><b>Plant Manager</b>                  Division of Fortune 1000 company seeks plant manager for plant located in the Vancouver area. This plant manufactures loading dock equipment for commercial markets. The candidate must be experienced in plant management including expertise in production planning, purchasing, and inventory management. Good written and oral communication skills are a must, along with excellent application of skills in managing people.</p>
2/23	<p><b>Operations Analyst</b>                  Expanding national coffee shop: top 10 "Best Places to Work" wants junior-level systems analyst to join our excellent store improvement team. Business or I.E. degree, work methods, labour standards, ergonomics, cost accounting knowledge a plus. This is a hands-on job and excellent opportunity for a team player with good people skills. West coast location. Some travel required.</p>
3/18	<p><b>Quality Manager</b>                  Several openings exist in our small package processing facilities in Montreal and Winnipeg for quality managers. These highly visible positions require extensive use of statistical tools to monitor all aspects of service, timeliness, and workload measurement. The work involves (1) a combination of hands-on applications and detailed analysis using databases and spreadsheets, (2) process audits to identify areas for improvement, and (3) management of implementation of changes. Positions involve night hours and weekends. Send résumé.</p>
4/6	<p><b>Supply Chain Manager and Planner</b>                  Responsibilities entail negotiating contracts and establishing long-term relationships with suppliers. We will rely on the selected candidate to maintain accuracy in the purchasing system, invoices, and product returns. A bachelor's degree and up to two years' related experience are required. Working knowledge of MRP, ability to use feedback to master scheduling and suppliers and consolidate orders for best price and delivery are necessary. Proficiency in all PC Windows applications, particularly Excel and Word, is essential. Knowledge of Oracle business systems is a plus. Effective verbal and written communication skills are essential.</p>
5/14	<p><b>Process Improvement Consultants</b>                  An expanding consulting firm is seeking consultants to design and implement lean production and cycle time reduction plans in both service and manufacturing processes. Our firm is currently working with an international bank to improve its back office operations, as well as with several manufacturing firms. A business degree required; APICS certification a plus.</p>

**FIGURE 1.3** Many Opportunities Exist for Operations Managers

Cost Focus		Quality Focus	Customization Focus
<p><b>Early Concepts</b>                      1776–1880                      Labour Specialization (Smith, Babbage)                      Standardized Parts (Whitney)</p>	<p><b>Mass Production Era</b>                      1910–1980                      Moving Assembly Line (Ford/Sorensen)                      Statistical Sampling (Shewhart)                      Economic Order Quantity (Harris)</p>	<p><b>Lean Production Era</b>                      1980–1995                      Just-in-Time (JIT)                      Computer-Aided Design (CAD)                      Electronic Data Interchange (EDI)                      Total Quality Management (TQM)</p>	<p><b>Mass Customization Era</b>                      1995–2015                      Globalization                      Internet/Ecommerce                      Enterprise Resource Planning                      International Quality Standards (ISO)                      Finite Scheduling                      Supply Chain Management</p>
<p><b>Scientific Management Era</b>                      1880–1910                      Gantt Charts (Gantt)                      Motion &amp; Time Studies (Gilbreth)                      Process Analysis (Taylor)                      Queuing Theory (Erlang)</p>	<p>PERT/CPM (DuPont)                      Material Requirements Planning (MRP)</p>	<p>Baldrige Award                      Empowerment                      Kanbans</p>	<p>Mass Customization                      Build-to-Order                      Sustainability</p>

**FIGURE 1.4** Significant Events in Operations Management



U.S. government for 10 000 muskets, he was able to command a premium price because of their interchangeable parts.

Frederick W. Taylor (1881), known as the father of scientific management, contributed to personnel selection, planning and scheduling, motion study, and the now popular field of ergonomics. One of his major contributions was his belief that management should be much more resourceful and aggressive in the improvement of work methods. Taylor and his colleagues, Henry L. Gantt and Frank and Lillian Gilbreth, were among the first to systematically seek the best way to produce.

Another of Taylor's contributions was the belief that management should assume more responsibility for:

1. Matching employees to the right job.
2. Providing the proper training.
3. Providing proper work methods and tools.
4. Establishing legitimate incentives for work to be accomplished.

By 1913, Henry Ford and Charles Sorensen combined what they knew about standardized parts with the quasi-assembly lines of the meatpacking and mail-order industries and added the revolutionary concept of the assembly line, where men stood still and material moved.

Quality control is another historically significant contribution to the field of OM. Walter Shewhart (1924) combined his knowledge of statistics with the need for quality control and provided the foundations for statistical sampling in quality control. W. Edwards Deming (1950) believed, as did Frederick Taylor, that management must do more to improve the work environment and processes so that quality can be improved.

Operations management will continue to progress with contributions from other disciplines, including *industrial engineering* and *management science*. These disciplines, along with statistics, management, and economics, contribute to improved models and decision making.

Innovations from the *physical sciences* (biology, anatomy, chemistry, and physics) have also contributed to advances in OM. These innovations include new adhesives, faster integrated circuits, gamma rays to sanitize food products, and higher-quality glass for LCD and plasma TVs. Innovation in products and processes often depends on advances in the physical sciences.

Especially important contributions to OM have come from *information technology*, which we define as the systematic processing of data to yield information. Information technology—with wireless links, internet, and ecommerce—is reducing costs and accelerating communication.

Decisions in operations management require individuals who are well versed in management science, in information technology, and often in one of the biological or physical sciences. In this textbook, we look at the diverse ways a student can prepare for a career in operations management.

## Operations in the Service Sector

**STUDENT TIP**

Services are especially important because almost 80% of all jobs are in service firms.

Manufacturers produce a tangible product, while service products are often intangible. But many products are a combination of a good and a service, which complicates the definition of a service. Even the Canadian government has trouble generating a consistent definition. Because definitions vary, much of the data and statistics generated about the service sector are inconsistent. However, we define **services** as including repair and maintenance, government, food and lodging, transportation, insurance, trade, financial, real estate, education, law, medicine, entertainment, and other professional occupations.

### Services

Economic activities that typically produce an intangible product (such as education, entertainment, lodging, government, financial, and health services).

### DIFFERENCES BETWEEN GOODS AND SERVICES

Let's examine some of the differences between goods and services:

- Services are usually *intangible* (for example, your purchase of a ride in an empty airline seat between two cities) as opposed to a tangible good.
- Services are often *produced and consumed simultaneously*; there is no stored inventory. For instance, the beauty salon produces a haircut that is “consumed” simultaneously, or the doctor produces an operation that is “consumed” as it is produced. We have not yet figured out how to inventory haircuts or appendectomies.
- Services are often *unique*. Your mix of financial coverage, such as investments and insurance policies, may not be the same as anyone else's, just as the medical procedure or a haircut produced for you is not exactly like anyone else's.
- Services have *high customer interaction*. Services are often difficult to standardize, automate, and make as efficient as we would like because customer interaction demands uniqueness. In fact, in many cases this uniqueness is what the customer is paying for; therefore, the operations manager must ensure that the product is designed (i.e., customized) so that it can be delivered in the required unique manner.
- Services have *inconsistent product definition*. Product definition may be rigorous, as in the case of an auto insurance policy, but inconsistent because policyholders change cars and policies mature.
- Services are often *knowledge based*, as in the case of educational, medical, and legal services, and therefore hard to automate.
- Services are frequently *dispersed*. Dispersion occurs because services are frequently brought to the client/customer via a local office, a retail outlet, or even a house call.

**LO2** Explain the distinction between goods and services

The activities of the operations function are often very similar for both goods and services. For instance, both goods and services must have quality standards established, and both must be designed and processed on a schedule in a facility where human resources are employed.

Having made the distinction between goods and services, we should point out that, in many cases, the distinction is not clear-cut. In reality, almost all services and almost all goods are a mixture of a service and a tangible product. Even services such as consulting may require a tangible report. Similarly, the sale of most goods includes a service. For instance, many products have the service components of financing and delivery (e.g., automobile sales). Many also require after-sale training and maintenance (e.g., office copiers and machinery). “Service” activities may also be an integral part of production. Human resource activities, logistics, accounting, training, field service, and repair are all service activities, but they take place within a manufacturing organization. Very few services are “pure,” meaning they have no tangible component. Counselling may be one of the exceptions.

### GROWTH OF SERVICES

Services constitute the largest economic sector in postindustrial societies. Until about 1900, many Canadians were employed in agriculture. Increased agricultural productivity allowed people to leave the farm and seek employment in the city. Similarly, manufacturing employment has decreased in North America in the past 30 years. The Canadian market tends to follow U.S. trends, as can be seen in the following comparison. The changes in U.S. agriculture, manufacturing, and service employment are shown in Figure 1.5. Although the number of people employed in manufacturing has decreased since 1950, each person is now producing almost 20 times more than in 1950. Services became the dominant employer in the early 1920s, with manufacturing employment peaking at about 32% in 1950. The huge productivity increases in