Thoroughly revised and updated for Excel®, this second edition of *Quantitative Methods in Health Care Management* offers a comprehensive introduction to quantitative methods and techniques for the student or new administrator. Its broad range of practical methods and analysis spans operational, tactical, and strategic decisions. Users will find techniques for forecasting, decision-making, facility location, facility layout, reengineering, staffing, scheduling, productivity, resource allocation, supply chain and inventory management, quality control, project management, queuing models for capacity, and simulation. The book’s step-by-step approach, use of Excel, and downloadable Excel templates make the text highly practical.

**Praise for the Second Edition**

“The second edition of Dr. Ozcan’s textbook is comprehensive and well-written with useful illustrative examples that give students and health care professionals a perfect toolkit for quantitative decision making in health care on the road for the twenty-first century. The text helps to explain the complex health care management problems and offer support for decision makers in this field.”

—Marion Rauner, associate professor, School of Business, Economics, and Statistics, University of Vienna.

“*Quantitative Methods in Health Care Administration, Second Edition* covers a broad set of necessary and important topics. It is a valuable text that is easy to teach and learn from.”

—David Belson, professor, Department of Industrial Engineering, Viterbi School of Engineering, University of Southern California.

**The Author**

**Yasar A. Ozcan, PhD,** is a professor of health administration at Virginia Commonwealth University. He is editor-in-chief of the *Journal of Health Care Management Science* and past president of the Health Care Applications Section of the Institute for Operations Research and Management Science.
QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT
QUANTITATIVE METHODS IN HEALTH CARE MANAGEMENT
Techniques and Applications

Second Edition

YASAR A. OZCAN

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CONTENTS

Tables, Figures, & Exhibits ix
Foreword xix
Acknowledgments xxix
The Author xxxi
Introduction xxv

1 INTRODUCTION TO QUANTITATIVE DECISION-MAKING METHODS IN HEALTH CARE MANAGEMENT 1
   Historical Background and the Development of Decision Techniques 2
   The Health Care Manager and Decision Making 3
   Information Technology (IT) and Health Care Management 3
   The Scope of Health Care Services, and Recent Trends 4
   Health Care Services Management 6
   Distinctive Characteristics of Health Care Services 6
   Summary 9
   Key Terms 9

2 FORECASTING 11
   Steps in the Forecasting Process 12
   Forecasting Approaches 13
   Summary 44
   Key Terms 44
   Exercises 45

3 DECISION MAKING IN HEALTH CARE FACILITIES 51
   The Decision Process 52
   The Decision Tree Approach 66
Contents

Decision Analysis with Nonmonetary Values and Multiple Attributes 68
Summary 73
Key Terms 73
Exercises 73

4 FACILITY LOCATION 81
Location Methods 83
Summary 99
Key Terms 99
Exercises 99

5 FACILITY LAYOUT 103
Product Layout 104
Process Layout 105
Summary 116
Key Terms 116
Exercises 116

6 REENGINEERING 121
Work Design in Health Care Organizations 123
Summary 155
Key Terms 155
Exercises 155

7 STAFFING 161
Workload Management Overview 162
Summary 182
Key Terms 182
Exercises 182

8 SCHEDULING 187
Staff Scheduling 187
Summary 202
Key Terms 202
Exercises 203
## Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>PRODUCTIVITY</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td>Trends in Health Care Productivity: Consequences of PPS</td>
<td>206</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>231</td>
</tr>
<tr>
<td></td>
<td>Key Terms</td>
<td>231</td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>232</td>
</tr>
<tr>
<td>10</td>
<td>RESOURCE ALLOCATION</td>
<td>237</td>
</tr>
<tr>
<td></td>
<td>Linear Programming</td>
<td>237</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>258</td>
</tr>
<tr>
<td></td>
<td>Key Terms</td>
<td>258</td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>258</td>
</tr>
<tr>
<td>11</td>
<td>SUPPLY CHAIN AND INVENTORY MANAGEMENT</td>
<td>263</td>
</tr>
<tr>
<td></td>
<td>Health Care Supply Chain</td>
<td>263</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>Key Terms</td>
<td>285</td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>285</td>
</tr>
<tr>
<td>12</td>
<td>QUALITY CONTROL</td>
<td>289</td>
</tr>
<tr>
<td></td>
<td>Quality in Health Care</td>
<td>289</td>
</tr>
<tr>
<td></td>
<td>Quality Measurement and Control Techniques</td>
<td>296</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>318</td>
</tr>
<tr>
<td></td>
<td>Key Terms</td>
<td>320</td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>320</td>
</tr>
<tr>
<td>13</td>
<td>PROJECT MANAGEMENT</td>
<td>327</td>
</tr>
<tr>
<td></td>
<td>The Characteristics of Projects</td>
<td>328</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>353</td>
</tr>
<tr>
<td></td>
<td>Key Terms</td>
<td>354</td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>354</td>
</tr>
<tr>
<td>14</td>
<td>QUEUING MODELS AND CAPACITY PLANNING</td>
<td>365</td>
</tr>
<tr>
<td></td>
<td>Capacity Analysis and Costs</td>
<td>382</td>
</tr>
<tr>
<td></td>
<td>Summary</td>
<td>384</td>
</tr>
<tr>
<td></td>
<td>Key Terms</td>
<td>386</td>
</tr>
<tr>
<td></td>
<td>Exercises</td>
<td>386</td>
</tr>
</tbody>
</table>
TABLES

1.1. Total Expenditures on Health as % GDP for 30 OECD Countries 4
1.2. Distribution of Health Providers and Health Workers in Health Services in 2006, and Expected Growth 5
1.3. Health Services by Occupation in 2006, and Projected Growth 7
2.1. Heal-Me Hospital Average Daily Patient Days 35
2.2. Quarterly Indexes for Heal-Me Hospital 37
2.3. Monthly Indexes for Heal-Me Hospital 37
2.4. Daily Indexes for Heal-Me Hospital 38
2.5. Monthly and Daily Adjusted Forecasts for Heal-Me Hospital 40
2.6. Error Calculations 41
3.1. Payoff Table 55
3.2. Demand for Additional MRIs 56
3.3. Maximin Solution 57
3.4. Maximax Solution 57
3.5. Sensitivity Analysis Using Hurwitz Optimism Parameters 59
3.6. Opportunity Losses (Regrets) 59
3.7. Laplace Strategy 60
3.8. Payoff Table for EMV 63
3.9. Expected Opportunity Loss 63
3.10. Best Outcomes Under Certainty 65
3.11. Total Cost of Alternatives Under Various Demand Conditions 65
3.12. Regret Table Using Costs 66
3.13. Summary of Supplier Proposals 71
4.1. Factors to be Considered in Establishing a Satellite Clinic 87
4.2. Relative Scores on Factors for a Satellite Clinic 89
4.3. Relative Factor Scores and Weights 89
4.4. Composite Scores 90
Contents

13.1. Activity Precedence Relationships 332
13.2. Path Lengths for the Radiation Oncology Project 335
13.3. Probabilistic Time Estimates for Radiation Oncology Clinic 341
13.4. Calculation of Expected Time and Standard Deviations on Each Path for the Radiation Oncology Clinic 342
13.5. Path Completion Probabilities 344
13.6. Project Completion Probabilities 346
14.1. Summary Analysis for M/M/s Queue for Diabetes Information Booth 385
15.1. Simple Simulation Experiment for Public Clinic 396
15.2. Summary Statistics for Public Clinic Experiment 397
15.3. Patient Arrival Frequencies 399
15.4. Probability Distribution for Patient Arrivals 400
15.5. Cumulative Poisson Probabilities for \( \lambda = 1.7 \) 401
15.6. Cumulative Poisson Probabilities for Arrivals: \( \lambda = 1.7 \) 402
15.7. Monte Carlo Simulation Experiment for Public Health Clinic 403
15.8. Summary Statistics for Public Clinic Monte Carlo Simulation Experiment 405

FIGURES

2.1. Seasonal Variation Characteristics 15
2.2. Cycle Variation 15
2.3. Random Variation and Trend 15
2.4. Excel Template Solution: Moving Average (MA_3) for OB/GYN Clinic 17
2.5. Excel Template Solution: Weighted Moving Average (WMA_3) for OB/GYN Clinic 20
2.6. Excel Template Solutions to the OB/GYN Example, Using Single Exponential Smoothing (SES) with \( \alpha = 0.3 \) and \( \alpha = 0.5 \) 22
2.7. Excel Template Solutions to the OB/GYN Example, Using Single Exponential Smoothing (SES) with \( \alpha = 0 \) and \( \alpha = 1.0 \) 24
2.8. Linear Regression 25
2.9. Excel Setup – Linear Regression for the Multihospital System Example 27
2.10. Excel Solution to the Multihospital System Example 28
2.11. Linear Regression as a Trend 29
2.12. Excel Linear Trend Graphic Solution to the OB/GYN Example 30
## Contents

2.13. Excel Template Solution to the OB/GYN Example 30
2.14. Excel Template – SEST Solution to Example 2.9 33
2.15. Seasonality-Removed Trend Data for Heal-Me Hospital Patient Demand 39
2.16. Alternative Forecasting Methods and Accuracy, Measured by MAD and MAPE 42
2.17. Linear Trend with Tracking Signal for Patient Visit Forecast, Heal-Me Hospital 43
2.18. Tracking Signal for Patient Visit Forecast, Heal-Me Hospital 44
3.1. Decision Tree 67
3.2. Rollback Method 68
3.3. Payoff Table Analysis Using Excel Template for Decision Analysis 69
3.4. Decision Tree and Rollback Procedure Using Excel Template for Decision Analysis 70
4.1. Total Cost of Alternative Imaging Sites 85
4.2. Profit Evaluation of Alternative Sites 86
4.3. Richmond Metropolitan Area Hospitals 94
4.4. Richmond Metropolitan Area Blood Bank Locations 97
4.5. Geographic Information Systems 98
5.1. Available Space for Layout of Long-Term Care Facility 106
5.2. Closeness Rating Chart for Long-Term Care Facility 107
5.3. A and X Closeness Representation 108
5.4. Layout Solution 108
5.5. Excel Template Solution 115
5.6. Excel Template Solution and Final Layout for a Small Hospital 115
6.1. Work Design—A Systems Perspective 124
6.2. Socio-Technical School Approach 127
6.3. Random Observation Schedule 147
6.4. Stabilized Dates and Times 148
6.5. Valid Dates and Times 149
6.6. Final Observation Schedule 150
6.7. Flow Process Chart for Emergency Room Specimen Processing 152
6.8. Commonly Used Flow Chart Symbols 153
6.9. Flow Chart for Emergency Room Specimen Processing 154
7.1. Workload Management 163
7.2. Distribution of Daily Workload on a Nursing Unit 178
7.3. Workload Standard Tolerance Ranges 180
8.1. Comparison of Eight- and Ten-Hour Shifts 189
8.2. Pattern of Alternating Eight- and Twelve-Hour Shifts 190
9.1. Productivity and Quality Trade-Off 223
9.2. Substitution of Physicians and Nurse Practitioners: A Look at Technical Efficiency 226
9.3. Example of DEA Efficiency Frontier Formulation 229
10.1. Graphic Solution for Insurance Company Problem 242
10.2. Excel Setup for the Insurance Company Problem 243
10.3. Excel Solver 244
10.4. Identifying Constraints and Solution Cells 244
10.5. Selection of Solution Reports 245
10.6. Answer Report 246
10.7. Sensitivity Report 247
10.8. Limits Report 248
10.10. Graphic Solution for Minimization Example 250
10.11. Excel Setup for the Minimization Problem 251
10.12. Solution to the Minimization Problem 251
10.13. Minimization Problem Answer Report 252
10.15. Minimization Problem Limits Report 253
10.16. Integer Programming: Excel Setup for the Staff Scheduling Problem 255
10.17. Identifying Constraints and Integer Values 255
10.18. Solution to the Staff Scheduling Problem 256
10.19. Answer Report for the Staff Scheduling Problem 256
11.1. Health Care Supply Chain 264
11.2. The Inventory Order Cycle for Basic EOQ Model 276
11.3. The Economic Ordering Quantity Model 277
11.4. Excel Solution to the Syringe Problem 282
11.5. Multi-Item Inventory EOQ and ABC Analysis 283
12.1. Quality Measurement 290
12.2. The Deming Wheel/Shewhart Cycle 294
## Contents

12.3. Process Capability 297  
12.4. Control Limits, Random and Nonrandom Sample Observations 299  
12.5. ABC Medical Center Infection Control Monitoring 301  
12.6. Holistic Care Corporation’s Quality Monitoring 304  
12.7. Use of Mean and Range Charts 305  
12.8. Identification of Runs 310  
12.9. Zone Test 313  
12.10. A Check Sheet and Corresponding Histogram for Emergency Room Wait Times 316  
12.11. Scatter Diagram 317  
12.13. Cause-and-Effect Diagram 319  
13.1. Network Representations 333  
13.2. AON Network Diagram for Radiation Oncology 334  
13.3. Activity Start and Finish Times 336  
13.4. Excel Setup and Solution to the Radiation Oncology Project, CPM Version 338  
13.5. Project Completion Probabilities by the Specified Time 343  
13.6. Completion Probabilities for Sixty-Five Weeks 344  
13.7. Excel Setup and Solution to the Probabilistic Radiation Oncology Project 345  
13.8. Project Duration and Compression (Crashing) Costs 348  
13.9. Project Compression 349  
13.10. Total Cost of Compression 353  
14.1. Queue Phenomenon 366  
14.2. Health Care Service Capacity and Costs 367  
14.3. Queuing Conceptualization of Flu Inoculations 368  
14.5. Multiple-Line Queuing System 370  
14.6. Emergency Room Arrival Patterns 371  
14.7. Measures of Arrival Patterns 372  
14.8. Poisson Distribution 373  
14.9. Service Time for ER Patients 373
14.10. Excel Setup and Solution to the Diabetes Information Booth Problem 379
14.11. System Probability Summary for Diabetes Information Booth 380
14.12. System Performance for Expanded Diabetes Information Booth 382
14.13. System Performance Summary for Expanded Diabetes Information Booth with M/M/3 383
15.1. Random Numbers 401
15.2. Excel-Based Simulated Arrivals 406
15.3. Excel Program for Simulated Arrivals 407
15.4. Performance-Measure-Based Managerial Decision Making 407

EXHIBITS
5.1. From-To Chart for a Small Hospital 111
8.1. Cyclical Staffing Schedules for Four and Five Weeks 192
8.2. An Example of OR Block Schedule: Surgical Suite Scheduling Method 199
13.1 Gantt Chart for Launching a New Radiation Oncology Service 331
14.1 Queuing Model Classification 374
14.2 Queuing Model Notation 376
To my wife, Gulperi, and my daughters, Gunes and Nilufer
I would like to congratulate Professor Yasar Ozcan on producing this excellent, comprehensive textbook, *Quantitative Methods in Health Care Management*. The field has needed such a textbook for a very long time, and Professor Ozcan is eminently qualified in bringing it to us.

The last textbook in this area was written over twenty years ago. To all of us in health services research and management, we know that health care delivery today bears little resemblance to that era. So too, the use, types, and depth of quantitative methods and techniques have progressed greatly in this time period. Professor Ozcan brings us not only the latest and best methods and techniques, but also illustrates their uses through current cases and examples.

And what I like best about this textbook is that it has been written by one of the leading and most knowledgeable health care management professors in the world. Professor Ozcan has been at the forefront in developing and applying many of the methods in the book, and as founding editor of the journal *Health Care Management Science*, he draws on the latest knowledge available from other areas.

For those of us who teach quantitative methods in health care management courses, this book will make our task far easier. More importantly, it will provide our students with a comprehensive text that they can draw on in their health care management careers. In addition, this text is a welcome, comprehensive, and up-to-date addition to the work of current managers and to all those who say, “There must be a better way to deliver health care.”

Indeed there is, and the application of the methods and ideas in this book will provide many, many answers.

William P. Pierskalla, Ph.D.
Distinguished Professor and Dean Emeritus,
The Anderson School, UCLA,
and Ronald Rosenfeld Professor Emeritus,
The Wharton School, University of Pennsylvania
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No book can be written on time without the support and encouragement of loved ones. I am indebted to my wife, Gulperi Ozcan, who became my sounding board for every example in this book. Moreover, she extended her support throughout the development of the manuscript even as I deprived her of my time in favor of my desktop. I thank her for the sustained support she has given me throughout my academic career and our personal life.

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May 15, 2008
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Yasar A. Ozcan, Ph.D. is a professor in the Department of Health Administration, Virginia Commonwealth University (VCU), where he has served as a faculty member for over thirty years. Dr. Ozcan teaches quantitative health care management courses in graduate professional programs in health administration, and methodology courses at the doctoral level. He has served twice as president of the Health Applications Section in the Institute of Operations Research and Management Science. Professor Ozcan is the founding Editor in Chief of a highly regarded journal, *Health Care Management Science*, and coeditor of the *Journal of Central Asian Health Services Research*.

Dr. Ozcan has been principal and co-principal investigator on various federal and state grants and contracts. He has also provided management consultancy services to health care facilities and managed care organizations.

Dr. Ozcan’s scholarly work is in the areas of systems productivity, technical efficiency, financial efficiency, and effectiveness. Specifically, he has applied data envelopment analysis to measure efficiency across the range of health care facilities and practices, including hospitals, nursing homes, health maintenance organizations, mental health care organizations, physician practices, and other facilities. He has presented numerous papers in professional meetings and published extensively in these areas.

Dr. Ozcan has long been active in distance education, having taught quantitative techniques, the content of this book, both in the traditional and on-line graduate programs at VCU since 1988.
INTRODUCTION

This book is written to meet the need for a quantitative methods curriculum in health administration or health care management programs. It is designed so that it can be used for one-semester courses in graduate programs as well as for advanced undergraduate programs in health administration. Practical and contemporary examples from the field make it a useful reference book for health care managers, as well.

The quantitative techniques offered in this book are those more amenable to the health care management environment and those most frequently used. The second edition employs the use of Excel. Although the simpler examples are demonstrated in the text, their Excel solutions are also provided. As techniques increase in sophistication, as for example in queuing models, Excel template solutions are preferred to lengthy formulas and look-up tables. The second edition also incorporates learning objectives at the beginning of each chapter and key terms at the end of each chapter to facilitate the appropriate pedagogy for learning. Because the intent of the book is to make students into able users of quantitative methods for decision making, the interpretation of the results from hand-calculated or Excel solutions to guide for informed decision making is the foremost goal. Thus, students who have had basic algebra and introductory statistics courses should be able to follow the contents of this book.

The book has fifteen chapters including the introductory chapter. The presentation of quantitative techniques starts with forecasting, which provides the data for many of the other techniques discussed, as well as for planning in health care facilities. The chapter on decision making provides the decision techniques not only for single attribute decision theory, but also for the multi-attribute methods often used in health care management decisions, especially in evaluating new contracts or in requests for proposals.

Chapters Four and Five provide techniques for facility location and layout. The techniques discussed for layout also can be used to improve flows in facilities. Hence, in Chapter Six, reengineering is introduced as the means to identify bottlenecks in operational processes and to correct them. Chapters Seven and Eight cover staffing and resource scheduling management in health care facilities; surgical suite resource management is highlighted. These two chapters can be assigned and covered together in one session. Chapter Nine, on productivity, not only presents the traditional productivity concepts and their measurements in both inpatient and outpatient settings, but also discusses more contemporary methods of productivity measurements as conducted through data envelopment analysis.
Chapter Ten explains linear programming and its use in resource allocation. Furthermore, integer programming, an extension of linear programming, is discussed and illustrated for staff scheduling. Supply chain management in health care has become popular in recent decades, and the first part of Chapter Eleven discusses that; the second part of the chapter is devoted to traditional techniques for inventory management. Quality control, essential above all in health care, is discussed in Chapter Twelve. Types of control charts and their developments are illustrated. Several approaches to quality control, including total quality management, continuous quality improvement, and six-sigma, are discussed. The tools for quality improvement are presented.

Project management is the subject of Chapter Thirteen, where program evaluation and review technique/critical path method (PERT/CPM) techniques are discussed in detail, with examples of project compression. The last two chapters cover queuing and simulation techniques with emphasis on capacity decisions using those tools. Simple queuing methods are shown with detailed examples. More sophisticated ones are illustrated by Excel solutions.

The sequence of chapters has a certain logic. For example, in Chapter Four, the location of a new facility is identified; and in Chapter Five, layout of that facility can be explored. On the other hand, Chapter Five can be also used in an independent layout analysis for existing facilities to improve flow and productivity. Similarly, Chapters Six, Seven, Eight and Nine are built to feed the knowledge onward. Chapters Fourteen and Fifteen address capacity issues using different techniques. Regardless of this sequence, however, the chapters can be selected in any order and presented to students based on the professor’s preferences.

Developing exercises for the techniques explained in each chapter has been a consuming task. Any errors and oversights in that process are solely mine. I will appreciate reader comments to improve or correct the exercises, as well as suggestions for incorporating additional material in future editions.

There are on-line resources to accompany this book. On-line resources (password protected) are available to professors who adopt the book and to the students. Professors’ resources include PowerPoint lectures, solutions to exercises, prototype course syllabus, Excel templates, and additional exercises with solutions. Student resources include solutions to selected exercises, Excel templates, a subset of additional exercises with solutions, and other study guide materials. These resources can be accessed via www.josseybass.com/go/ozcan2e.
CHAPTER

1

INTRODUCTION TO QUANTITATIVE DECISION-MAKING METHODS IN HEALTH CARE MANAGEMENT

LEARNING OBJECTIVES:

■ Recognize the quantitative techniques for decisions about delivering health care of high quality.
■ Describe the historical background and the development of decision techniques.
■ Describe the health care manager’s role and responsibilities in decision making.
■ Review the scope of health services and follow recent trends in health care.
■ Describe health services management and distinct characteristics of health services.
In today’s highly complicated, technological, and competitive health care arena, the public’s outcry is for administrators, physicians, and other health care professionals to provide high quality care at a lower cost. Health care managers must therefore find ways to get excellent results from more limited resources. The goal of this book is to introduce aspiring health care managers to operations research models that allow decision makers to sort out complex issues and to make the best possible use of available resources. Such models are used, for example, to forecast patient demand, and to guide capital acquisition and capacity decisions, facility planning, personnel and patient scheduling, supply chain, and quality control. They use mathematical and statistical techniques: multivariate statistical analysis, decision analysis, linear programming, project evaluation and review technique (PERT), queuing analysis, and simulation, to name a few.

This book presents all these techniques from the perspective of health care organizations’ delivery of care, rather than their traditional manufacturing applications. This chapter covers a brief historical background and the development of decision techniques and explains the importance of health care managers using these techniques. Finally, the scope, distinctive characteristics, and current trends of health services are emphasized. After reading this chapter, you should have a fair understanding of how important quantitative techniques are for decisions about delivering health care of high quality.

**HISTORICAL BACKGROUND AND THE DEVELOPMENT OF DECISION TECHNIQUES**

Beginning in the 1880s, the scientific management era brought about widespread changes in the management of the factories that had been created at an explosive rate during the Industrial Revolution. The movement was spearheaded by an efficiency engineer and inventor, Frederick Winslow Taylor, who is regarded as the father of modern scientific management. Taylor proposed a “science of management” based on observation, measurement, analysis, and improvement of work methods, along with economic incentives. He also believed that management’s tasks are to plan, carefully select and train workers, find the best way to perform each job, achieve cooperation between management and workers, and separate management activities from work activities. Taylor’s work was based on his idea that conflicts between labor and management occur because management has no idea how long jobs actually take. He therefore focused on time studies that evaluated work methods in great detail to identify the best way to do each job. Taylor’s classic 1911 book, *The Principles of Scientific Management*, explained these guiding principles: (1) development of science for each element of work; (2) scientific selection and training of workers; (3) cooperation between management and employees; and (4) responsibility shared equally between workers and management (Taylor, 1911). Other early contributors to scientific methods of management were Frank and Gillian Gilbreth, who worked on standardization, and Henry Gantt, who emphasized the psychological effects that work conditions have on employees—he developed a time-based display chart to schedule work. Quantitative inventory management was developed by F. W. Harris in 1915. In the 1930s, W. Shewhart and associates developed