Contents

Preface xi

1. Introduction to Business Process Design 1
   1.1 What Is a Business Process? 1
      1.1.1 Process Types and Hierarchies 3
      1.1.2 Determinants of the Process Architecture 4
         1.1.2.1 Inputs and Outputs 5
         1.1.2.2 Flow Units 5
         1.1.2.3 Network of Activities and Buffers 5
         1.1.2.4 Resources 8
         1.1.2.5 Information Structure 8
      1.1.3 Workflow Management Systems 9
   1.2 Essence of Business Process Design 10
      1.2.1 Incremental Process Improvement and Process Design 12
      1.2.2 Illustrative Example 13
   1.3 Business Process Design, Overall Business Performance, and Strategy 16
      1.3.1 Business Process Design and Overall Business Performance 16
      1.3.2 Business Process Design and Strategy 17
   1.4 Why Do Inefficient and Ineffective Business Processes Exist? 18
   1.5 Summary 20
   Discussion Questions and Exercises 21
   References 25

2. Process Management and Process-Oriented Improvement Programs 27
   2.1 Process Management and the Power of Adopting a Process View 27
      2.1.1 Phase I: Initialization 29
         2.1.1.1 Process Ownership 30
         2.1.1.2 Analyzing Process Boundaries and Interfaces 31
      2.1.2 Phase II: Definition 33
      2.1.3 Phase III: Control 34
         2.1.3.1 Establishing Control Points 34
         2.1.3.2 Developing and Implementing Measurements 35
         2.1.3.3 Feedback and Control 36
      2.1.4 Illustrative Example: Managing a Document Distribution Process 36
         2.1.4.1 Assign Process Ownership 37
         2.1.4.2 Analyze Boundaries and Interfaces 37
         2.1.4.3 Define the Process 39
         2.1.4.4 Establish Control Points 40
         2.1.4.5 Develop and Implement Measures 40
         2.1.4.6 Perform Feedback and Control 41
         2.1.4.7 Summary and Final Remarks 41
   2.2 Six Sigma Quality Programs 42
      2.2.1 Six Sigma Definitions 42
      2.2.2 Six Sigma Cost and Revenue Rationale 44
2.2.2.1 Cost or Efficiency Rationale ........................................... 44
2.2.2.2 Revenue or Effectiveness Rationale ................................. 46
2.2.3 Six Sigma in Product and Process Design ....................... 47
2.2.4 Six Sigma Framework .................................................. 48
2.2.4.1 Top-Management Commitment ................................. 48
2.2.4.2 Stakeholder Involvement .................................... 48
2.2.4.3 Training .......................................................... 49
2.2.4.4 Measurement System ....................................... 50
2.2.4.5 Improvement Methodology .................................... 50
2.2.5 Concluding Remarks: Key Reasons for the Success of Six Sigma ................................. 51

2.3 Business Process Reengineering ...................................... 52
2.3.1 Reengineering and Its Relationship with Other Earlier Programs .......... 54
2.3.2 Brief History of Reengineering .................................. 56
2.3.3 When Should a Process Be Reengineered? ....................... 58
2.3.4 What Should Be Reengineered? ................................ 60
2.3.4.1 Dysfunction .................................................. 61
2.3.4.2 Importance .................................................. 62
2.3.4.3 Feasibility .................................................. 62
2.3.5 Suggested Reengineering Frameworks ............................ 63

2.4 Revolutionary versus Evolutionary Change ....................... 66

2.5 Summary .................................................................. 69

Discussion Questions and Exercises .................................... 71
References ......................................................................... 73

3. Framework for Business Process-Design Projects ............... 75
3.1 Step 1: Case for Action and Vision Statements .................. 77
3.2 Step 2: Process Identification and Selection ..................... 79
3.3 Step 3: Obtaining Management Commitment ..................... 81
3.4 Step 4: Evaluation of Design Enablers .............................. 81
3.4.1 Example: Internet-Enabling Change at Chase Manhattan Bank .... 83
3.4.2 Example: New Technology as a Change Enabler in the Grocery Industry .................................................. 84
3.5 Step 5: Acquiring Process Understanding .......................... 86
3.5.1 Understanding the Existing Process ............................... 86
3.5.2 Understanding the Customer ...................................... 88
3.6 Step 6: Creative Process Design ...................................... 89
3.6.1 Benchmarking ..................................................... 91
3.6.2 Design Principles ................................................ 92
3.7 Step 7: Process Modeling and Simulation ......................... 99
3.8 Step 8: Implementation of the New Process Design .......... 101
3.9 Summary .................................................................. 103
Discussion Questions and Exercises .................................... 104
References ......................................................................... 105

4. Basic Tools for Process Design ......................................... 107
4.1 Process Flow Analysis ............................................... 109
4.1.1 General Process Charts ........................................ 110
4.1.2 Process Flow Diagrams ........................................ 111
4.1.3 Process Activity Charts ........................................ 114
4.1.4 Flowcharts ........................................... 115
4.1.5 Service System Maps ................................ 117
4.2 Workflow Design Principles and Tools ............... 121
4.2.1 Establish a Product Orientation in the Process .... 121
4.2.2 Eliminate Buffers .................................. 124
4.2.3 Establish One-at-a-Time Processing ............... 125
4.2.4 Balance the Flow to the Bottleneck ............... 126
4.2.5 Minimize Sequential Processing and Handoffs ...... 130
4.2.6 Establish an Efficient System for Processing of Work 131
4.2.7 Minimize Multiple Paths through Operations ....... 136
4.3 Additional Diagramming Tools ......................... 137
4.4 From Theory to Practice: Designing an Order-Picking Process ....... 138
4.5 Summary ............................................. 139
Discussion Questions and Exercises ....................... 140
References .................................................. 145

5. Managing Process Flows .................................. 147
5.1 Business Processes and Flows ......................... 147
5.1.1 Throughput Rate .................................... 149
5.1.2 Work-in-Process ................................... 150
5.1.3 Cycle Time ......................................... 152
5.1.4 Little's Law ....................................... 153
5.2 Cycle Time and Capacity Analysis ..................... 154
5.2.1 Cycle Time Analysis ................................ 154
5.2.1.1 Rework ........................................ 155
5.2.1.2 Multiple Paths ................................ 156
5.2.1.3 Parallel Activities ............................. 157
5.2.2 Capacity Analysis .................................. 160
5.2.2.1 Rework ........................................ 160
5.2.2.2 Multiple Paths ................................ 161
5.2.2.3 Parallel Activities ............................. 162
5.3 Managing Cycle Time and Capacity ................. 164
5.3.1 Cycle Time Reduction ................................ 164
5.3.2 Increasing Process Capacity ....................... 166
5.4 Theory of Constraints ................................ 168
5.4.1 Drum–Buffer–Rope Systems ....................... 173
5.5 Summary ............................................. 174
Discussion Questions and Exercises ....................... 174
References .................................................. 182

6. Introduction to Queuing Modeling ...................... 183
6.1 The Basic Queuing Process, Queuing Systems, and Queuing Strategies ....... 185
6.1.1 The Basic Queuing Process ......................... 186
6.1.1.1 Calling Population ............................. 187
6.1.1.2 Arrival Process ................................ 188
6.1.1.3 Queue Configuration .......................... 188
6.1.1.4 Queue Discipline .............................. 190
6.1.1.5 Service Mechanism ............................ 191
6.1.2 Strategies for Mitigating the Effects of Long Queues ................... 191
6.2 Analytical Queuing Models .................................................. 192
  6.2.1 The Exponential Distribution and Its Role in Queuing Theory 194
    6.2.1.1 The Exponential Distribution, The Poisson Distribution, and The Poisson Process 197
  6.2.2 Terminology, Notation, and Little's Law Revisited .................. 199
  6.2.3 Birth-and-Death Processes .............................................. 203
  6.2.4 The M/M/1 Model ...................................................... 212
  6.2.5 The M/M/c Model ....................................................... 216
  6.2.6 The M/M/c/K Model .................................................... 220
  6.2.7 The M/M/c/∞/N Model .................................................. 223
  6.2.8 Queuing Theory and Process Design .................................. 228
    6.2.8.1 Determining WC .................................................. 230
    6.2.8.2 Determining SC .................................................. 230
    6.2.8.3 Decision Model for Designing Queuing Systems .................. 231
  6.3 Summary ................................................................. 237

Appendix 6A: Mathematical Derivations and Models with Generally
  Distributed Service Times .................................................. 238

Discussion Questions and Exercises ......................................... 242
References ................................................................. 252

7. Introduction to Simulation .................................................. 253
  7.1 Simulation Models ....................................................... 255
  7.2 Discrete-Event Simulation ................................................. 257
  7.3 Getting Started in Simulation Modeling ................................ 259
  7.4 Illustrative Example ..................................................... 264
  7.5 Spreadsheet Simulation of a Process .................................... 271
  7.6 Successful Simulation in Practice ....................................... 273
  7.7 When Not to Simulate .................................................... 275
  7.8 Summary ................................................................. 278

Discussion Questions and Exercises ......................................... 279
References ................................................................. 281

8. Modeling and Simulating Business Processes with ExtendSim .......... 283
  8.1 Developing a Simulation Model: Principles and Concepts .......... 284
    8.1.1 Model Verification .................................................. 285
    8.1.2 Model Validation ................................................... 286
  8.2 ExtendSim Elements ...................................................... 286
  8.3 ExtendSim Tutorial: A Basic Queuing Model ......................... 290
  8.4 Basic Data Collection and Statistical Analysis ....................... 294
  8.5 Adding Randomness to Processing Times and the Use of Attributes 298
  8.6 Adding a Second Underwriting Team .................................... 305
  8.7 Modeling Resources and Resource Pools ................................ 307
  8.8 Customizing the Animation ............................................... 310
  8.9 Calculating Activity-Based Costs ....................................... 312
  8.10 Cycle Time Analysis .................................................... 316
  8.11 Modeling Advanced Queuing Features .................................. 319
    8.11.1 Blocking ........................................................... 319
    8.11.2 Balking ............................................................. 320
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.11.3</td>
<td>Reneging</td>
<td>321</td>
</tr>
<tr>
<td>8.11.4</td>
<td>Priorities and Priority Queues</td>
<td>323</td>
</tr>
<tr>
<td>8.12</td>
<td>Modeling Routing in Multiple Paths and Parallel Paths</td>
<td>325</td>
</tr>
<tr>
<td>8.12.1</td>
<td>Multiple Paths</td>
<td>325</td>
</tr>
<tr>
<td>8.12.2</td>
<td>Parallel Paths</td>
<td>329</td>
</tr>
<tr>
<td>8.13</td>
<td>Model Documentation and Enhancements</td>
<td>331</td>
</tr>
<tr>
<td>8.14</td>
<td>Summary</td>
<td>333</td>
</tr>
<tr>
<td>Discussion Questions and Exercises</td>
<td></td>
<td>334</td>
</tr>
<tr>
<td>References</td>
<td></td>
<td>343</td>
</tr>
<tr>
<td>9.1</td>
<td>Input and Output Data Analysis</td>
<td>345</td>
</tr>
<tr>
<td>9.2</td>
<td>Dealing with Randomness</td>
<td>346</td>
</tr>
<tr>
<td>9.2.1</td>
<td>Characterizing Probability Distributions of Field Data</td>
<td>347</td>
</tr>
<tr>
<td>9.2.2</td>
<td>Goodness-of-Fit Tests</td>
<td>351</td>
</tr>
<tr>
<td>9.2.3</td>
<td>Using Stat::Fit for Distribution Fitting</td>
<td>351</td>
</tr>
<tr>
<td>9.2.4</td>
<td>Choosing a Distribution in the Absence of Sample Data</td>
<td>354</td>
</tr>
<tr>
<td>9.3</td>
<td>Random Number Generators</td>
<td>358</td>
</tr>
<tr>
<td>9.3.1</td>
<td>Runs Test</td>
<td>359</td>
</tr>
<tr>
<td>9.4</td>
<td>Generation of Random Variates</td>
<td>361</td>
</tr>
<tr>
<td>9.5</td>
<td>Analysis of Simulation Output Data</td>
<td>364</td>
</tr>
<tr>
<td>9.5.1</td>
<td>Nonterminating Processes</td>
<td>366</td>
</tr>
<tr>
<td>9.5.2</td>
<td>Terminating Processes</td>
<td>368</td>
</tr>
<tr>
<td>9.5.3</td>
<td>Confidence Intervals</td>
<td>370</td>
</tr>
<tr>
<td>9.5.3.1</td>
<td>Confidence Interval for a Population Mean</td>
<td>371</td>
</tr>
<tr>
<td>9.5.4</td>
<td>Sample Size Calculation</td>
<td>375</td>
</tr>
<tr>
<td>9.5.5</td>
<td>Comparing Output Variables for Different Process Designs</td>
<td>376</td>
</tr>
<tr>
<td>9.6</td>
<td>Modeling and Analysis of Process-Design Cases</td>
<td>379</td>
</tr>
<tr>
<td>9.6.1</td>
<td>Process Design of a Call Center for Software Support</td>
<td>380</td>
</tr>
<tr>
<td>9.6.2</td>
<td>Design of a Hospital Admissions Process</td>
<td>384</td>
</tr>
<tr>
<td>9.7</td>
<td>Summary</td>
<td>394</td>
</tr>
<tr>
<td>9.8</td>
<td>Training Cases</td>
<td>394</td>
</tr>
<tr>
<td>9.8.1</td>
<td>Case 1: Improving the X-Ray Process at County Hospital</td>
<td>394</td>
</tr>
<tr>
<td>9.8.2</td>
<td>Case 2: Process Modeling and Analysis in an Assembly Factory</td>
<td>398</td>
</tr>
<tr>
<td>9.8.3</td>
<td>Case 3: Redesign of a Credit Applications Process</td>
<td>401</td>
</tr>
<tr>
<td>9.8.4</td>
<td>Case 4: Redesigning the Adoption Process in a Humane Society</td>
<td>402</td>
</tr>
<tr>
<td>9.8.5</td>
<td>Case 5: Performance Analysis and Improvement of an Internet</td>
<td>404</td>
</tr>
<tr>
<td>Appendix 9A: Hypothesis Testing, Confidence Intervals, and Statistical Tables</td>
<td>407</td>
<td></td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td>419</td>
</tr>
<tr>
<td>References</td>
<td></td>
<td>423</td>
</tr>
<tr>
<td>10.1</td>
<td>Optimizing Business Process Performance</td>
<td>425</td>
</tr>
<tr>
<td>10.2</td>
<td>Business Process Optimization</td>
<td>425</td>
</tr>
<tr>
<td>10.3</td>
<td>Role of Simulation–Optimization in Business Process Management</td>
<td>427</td>
</tr>
<tr>
<td>10.3.1</td>
<td>Simulation–Optimization with ExtendSim</td>
<td>430</td>
</tr>
<tr>
<td>10.3.2</td>
<td>Tutorial: Process Optimization with ExtendSim</td>
<td>434</td>
</tr>
<tr>
<td>10.3.3</td>
<td>Alternative Optimization Models</td>
<td>441</td>
</tr>
</tbody>
</table>
10.4 Optimization of Process Simulation Models ............................................. 443
  10.4.1 Configuring a Hospital Emergency Room Process .......................... 443
  10.4.2 Staffing Levels for a Personal Insurance Claims Process ............... 446
10.5 Summary ................................................................................................. 448
Appendix 10A: Evolutionary Computation ................................................... 448
References ....................................................................................................... 457

11. Business Process Analytics ....................................................................... 459
  11.1 Competing on Analytics ....................................................................... 461
  11.2 Business Process Management Systems ............................................. 465
    11.2.1 Business Rules ........................................................................... 466
    11.2.2 Data Mining ............................................................................... 468
    11.2.3 Monitor and Control ................................................................... 474
    11.2.4 Process Mining .......................................................................... 474
  11.3 Process Benchmarking ......................................................................... 476
    11.3.1 Graphical Analysis of the Ratio Model ....................................... 479
      11.3.1.1 Efficiency Calculation .......................................................... 481
    11.3.2 Linear Programming Formulation of the Ratio Model ............... 483
    11.3.3 Learning from Best-Practice Organizations ............................... 485
  11.4 Final Thoughts ....................................................................................... 486
Appendix 11A: Excel® Add-In for Data Envelopment Analysis ................... 487
Discussion Questions and Exercises ............................................................... 493
References ....................................................................................................... 497

Appendix: Instructions for Downloading ExtendSim Demo or LT ............... 499

Index ............................................................................................................... 501