Contents

About the Authors  iv
Preface  v
Acknowledgments vii

Chapter 1
Introduction  1

Characteristics of Successful Product Development  2
Who Designs and Develops Products?  3
Duration and Cost of Product Development  5
The Challenges of Product Development  6
Approach of This Book  6
  Structured Methods  7
  Industrial Examples  7
  Organizational Realities  7
  Roadmap of the Book  8
References and Bibliography 10
Exercises 10
Thought Questions 10

Chapter 2
Development Processes and Organizations  11

The Product Development Process  12
Concept Development: The Front-End Process  16
Adapting the Generic Product Development Process  18
  Technology-Push Products  18
  Platform Products  20
  Process-Intensive Products  20
  Customized Products  20
  High-Risk Products  21
  Quick-Build Products  21
  Complex Systems  21
Product Development Process Flows  22
The Tyco Product Development Process  23

Chapter 3
Opportunity Identification  33

What Is an Opportunity?  34
Types of Opportunities  34
Tournament Structure of Opportunity Identification  36
  Effective Opportunity Tournaments  37
Opportunity Identification Process  39
  Step 1: Establish a Charter  39
  Step 2: Generate and Sense Many Opportunities  40
  Techniques for Generating Opportunities  40
  Step 3: Screen Opportunities  46
  Step 4: Develop Promising Opportunities  47
  Step 5: Select Exceptional Opportunities  47
  Step 6: Reflect on the Results and the Process  49
Summary  50
References and Bibliography  50
Exercises  51
Thought Questions  51

Chapter 4
Product Planning  53

The Product Planning Process  54
  Four Types of Product Development Projects  55
  The Process  56
Product Development Organizations  25
  Organizations Are Formed by Establishing Links among Individuals  25
  Organizational Links May Be Aligned with Functions, Projects, or Both  25
  Choosing an Organizational Structure  28
  Distributed Product Development Teams  28
The Tyco Product Development Organization  30
Summary  30
References and Bibliography  31
Exercises  32
Thought Questions  32
Step 1: Identify Opportunities  57
Step 2: Evaluate and Prioritize Projects  57
  Competitive Strategy  58
  Market Segmentation  58
  Technological Trajectories  59
  Product Platform Planning  60
  Evaluating Fundamentally New Product Opportunities  61
  Balancing the Portfolio  63
Step 3: Allocate Resources and Plan Timing  64
  Resource Allocation  64
  Project Timing  66
  The Product Plan  66
Step 4: Complete Pre-Project Planning  66
  Mission Statements  67
  Assumptions and Constraints  68
  Staffing and Other Pre-Project Planning Activities  69
Step 5: Reflect on the Results and the Process  69
Summary  70
References and Bibliography  70
Exercises  72
Thought Questions  72

Chapter 5
Identifying Customer Needs  73
Step 1: Gather Raw Data from Customers  76
  Choosing Customers  78
  The Art of Eliciting Customer Needs Data  79
  Documenting Interactions with Customers  80
Step 2: Interpret Raw Data in Terms of Customer Needs  81
Step 3: Organize the Needs into a Hierarchy  83
Step 4: Establish the Relative Importance of the Needs  86
Step 5: Reflect on the Results and the Process  87
Summary  88
References and Bibliography  88
Exercises  89
Thought Questions  90

Chapter 6
Product Specifications  91
What Are Specifications?  92
When Are Specifications Established?  93
Establishing Target Specifications  94
  Step 1: Prepare the List of Metrics  95
  Step 2: Collect Competitive Benchmarking Information  99
  Step 3: Set Ideal and Marginally Acceptable Target Values  99
  Step 4: Reflect on the Results and the Process  103
Setting the Final Specifications  103
  Step 1: Develop Technical Models of the Product  105
  Step 2: Develop a Cost Model of the Product  106
  Step 3: Refine the Specifications, Making Trade-Offs Where Necessary  108
  Step 4: Flow Down the Specifications as Appropriate  109
  Step 5: Reflect on the Results and the Process  111
Summary  111
References and Bibliography  112
Exercises  113
Thought Questions  113
Appendix
Target Costing  114

Chapter 7
Concept Generation  117
The Activity of Concept Generation  118
  Structured Approaches Reduce the Likelihood of Costly Problems  119
  A Five-Step Method  119
Step 1: Clarify the Problem  120
  Decompose a Complex Problem into Simpler Subproblems  121
  Focus Initial Efforts on the Critical Subproblems  123
Step 2: Search Externally  124
  Interview Lead Users  124
  Consult Experts  125
  Search Patents  125
  Search Published Literature  126
  Benchmark Related Products  127
Step 3: Search Internally  127
  Both Individual and Group Sessions Can Be Useful  128
  Hints for Generating Solution Concepts  129
Step 4: Explore Systematically 130
  Concept Classification Tree 132
  Concept Combination Table 134
  Managing the Exploration Process 137
Step 5: Reflect on the Solutions and the Process 139
Summary 140
References and Bibliography 141
Exercises 142
Thought Questions 142

Chapter 8
Concept Selection 143
Concept Selection Is an Integral Part of the Product Development Process 144
All Teams Use Some Method for Choosing a Concept 145
A Structured Method Offers Several Benefits 148
Overview of Methodology 149
Concept Screening 150
  Step 1: Prepare the Selection Matrix 150
  Step 2: Rate the Concepts 151
  Step 3: Rank the Concepts 152
  Step 4: Combine and Improve the Concepts 152
  Step 5: Select One or More Concepts 152
  Step 6: Reflect on the Results and the Process 153
Concept Scoring 154
  Step 1: Prepare the Selection Matrix 154
  Step 2: Rate the Concepts 155
  Step 3: Rank the Concepts 156
  Step 4: Combine and Improve the Concepts 156
  Step 5: Select One or More Concepts 156
  Step 6: Reflect on the Results and the Process 157
Caveats 157
Summary 159
References and Bibliography 159
Exercises 160
Thought Questions 161
Appendix A
Concept-Screening Matrix Example 162
Appendix B
Concept-Scoring Matrix Example 163

Chapter 9
Concept Testing 165
Step 1: Define the Purpose of the Concept Test 167
Step 2: Choose a Survey Population 167
Step 3: Choose a Survey Format 168
Step 4: Communicate the Concept 169
  Matching the Survey Format with the Means of Communicating the Concept 173
  Issues in Communicating the Concept 173
Step 5: Measure Customer Response 175
Step 6: Interpret the Results 175
Step 7: Reflect on the Results and the Process 178
Summary 179
References and Bibliography 179
Exercises 180
Thought Questions 180
Appendix
Estimating Market Sizes 181

Chapter 10
Product Architecture 183
What Is Product Architecture? 184
  Types of Modularity 186
  When Is the Product Architecture Defined? 187
Implications of the Architecture 187
  Product Change 187
  Product Variety 188
  Component Standardization 189
  Product Performance 189
  Manufacturability 190
  Product Development Management 191
Establishing the Architecture 191
  Step 1: Create a Schematic of the Product 192
  Step 2: Cluster the Elements of the Schematic 193
  Step 3: Create a Rough Geometric Layout 195
  Step 4: Identify the Fundamental and Incidental Interactions 196
Delayed Differentiation 197
Platform Planning 200
  Differentiation Plan 200
  Commonality Plan 201
  Managing the Trade-Off between Differentiation and Commonality 202
Chapter 11
Industrial Design 207

What Is Industrial Design? 209
Assessing the Need for Industrial Design 211

Expenditures for Industrial Design 211
How Important Is Industrial Design to a Product? 211
Ergonomic Needs 212
Aesthetic Needs 213

The Impact of Industrial Design 213

Is Industrial Design Worth the Investment? 213
How Does Industrial Design Establish a Corporate Identity? 216

The Industrial Design Process 217
1. Investigation of Customer Needs 217
2. Conceptualization 217
3. Preliminary Refinement 218
4. Further Refinement and Final Concept Selection 218
5. Control Drawings or Models 220
6. Coordination with Engineering, Manufacturing, and External Vendors 220

The Impact of Computer-Based Tools on the ID Process 220

Management of the Industrial Design Process 221

Timing of Industrial Design Involvement 222

Assessing the Quality of Industrial Design 224
1. Quality of the User Interface 224
2. Emotional Appeal 224
3. Ability to Maintain and Repair the Product 224
4. Appropriate Use of Resources 226
5. Product Differentiation 226

Summary 226
References and Bibliography 227
Exercises 228
Thought Questions 228

Appendix

Design for Environment Guidelines 250

Chapter 13
Design for Manufacturing 253

Design for Manufacturing Defined 255

DFM Requires a Cross-Functional Team 255

DFM Is Performed throughout the Development Process 255

Overview of the DFM Process 256

Step 1: Estimate the Manufacturing Costs 256

Transportation Costs 259
Fixed Costs versus Variable Costs 259

The Bill of Materials 260

Estimating the Costs of Standard Components 261
Chapter 16
Patents and Intellectual Property 331

What Is Intellectual Property? 332
- Overview of Patents 333
- Utility Patents 334
- Preparing a Disclosure 334

Step 1: Formulate a Strategy and Plan 336
- Timing of Patent Applications 336
- Type of Application 337
- Scope of Application 338

Step 2: Study Prior Inventions 338
Step 3: Outline Claims 339
Step 4: Write the Description of the Invention 340
- Figures 341

- Writing the Detailed Description 341
- Defensive Disclosure 342

Step 5: Refine Claims 343
- Writing the Claims 343
- Guidelines for Crafting Claims 346

Step 6: Pursue Application 346
Step 7: Reflect on the Results and the Process 348
Summary 348

References and Bibliography 349
Exercises 349
Thought Questions 349

Appendix A
Trademarks 350

Appendix B
Advice to Individual Inventors 350

Chapter 17
Product Development Economics 353

Elements of Economic Analysis 354
- Quantitative Analysis 354
- Qualitative Analysis 354

When Should Economic Analysis Be Performed? 355
Economic Analysis Process 356

Step 1: Build a Base-Case Financial Model 356
- Estimate the Timing and Magnitude of Future Cash Inflows and Outflows 356
- Compute the Net Present Value of the Cash Flows 358
- The Base-Case Financial Model Can Support Go/No-Go Decisions and Major Investment Decisions 359

Step 2: Perform Sensitivity Analysis 359
- Development Cost Example 360
- Development Time Example 361

Step 3: Use Sensitivity Analysis to Understand Project Trade-Offs 363
- Six Potential Interactions 364
- Trade-Off Rules 365
- Limitations of Quantitative Analysis 366

Step 4: Consider the Influence of the Qualitative Factors on Project Success 367
- Projects Interact with the Firm, the Market, and the Macro Environment 367
- Carrying Out Qualitative Analysis 369

Summary 370

References and Bibliography 371
Exercises 372
Thought Questions 372

Appendix A
Time Value of Money and the Net Present Value Technique 373

Appendix B
Modeling Uncertain Cash Flows Using Net Present Value Analysis 375

Chapter 18
Managing Projects 379

Understanding and Representing Tasks 380
- Sequential, Parallel, and Coupled Tasks 380
- The Design Structure Matrix 382
- Gantt Charts 383
- PERT Charts 384
- The Critical Path 384

Baseline Project Planning 385
- The Contract Book 385
- Project Task List 385
Contents

Team Staffing and Organization  387
  Project Schedule  388
  Project Budget  389
  Project Risk Plan  389
  Modifying the Baseline Plan  391
Accelerating Projects  391
Project Execution  394
  Coordination Mechanisms  394
  Assessing Project Status  396
  Corrective Actions  396
Postmortem Project Evaluation  398
Summary  399
References and Bibliography  400
Exercises  402
Thought Questions  402
Appendix
  Design Structure Matrix Example  403
Index  405