

CONTENTS

Acknowledgments	xv
1 Introduction	1
1.1 About This Book, 1	
1.2 Technology and Society, 2	
1.2.1 Social Change, 3	
1.2.2 Technological Change, 4	
1.3 Management and the Future, 6	
1.3.1 Management and Innovation Processes, 7	
1.3.2 The Role of Technology Forecasting, 9	
1.3.3 The Importance of Technology Forecasting, 10	
1.3.4 The Role of Social Forecasting, 12	
1.4 Conclusions, 13	
References, 13	
2 Technology Forecasting	15
2.1 What Is Technology Forecasting?, 15	
2.1.1 Models of Technology Growth and Diffusion, 17	
2.1.2 Technology Forecasting in Context, 18	
2.1.3 What Makes a Forecast Good?, 20	
2.1.4 Common Errors in Forecasting Technology, 21	

viii CONTENTS

- 2.2 Methodological Foundations, 23
 - 2.2.1 The Technology Delivery System, 24
 - 2.2.2 Inquiring Systems, 28
- 2.3 Technology Forecasting Methods, 31
 - 2.3.1 Overview of the Most Frequently Used Forecasting Methods, 33
 - 2.3.2 Method Selection, 37
- 2.4 Conclusion, 37
 - References, 38

3 Managing the Forecasting Project 40

- 3.1 Information Needs of the Forecasting Project, 40
 - 3.1.1 The Technology Manager's Needs, 42
 - 3.1.2 The Forecast Manager's Needs, 43
 - 3.1.3 Information about Team Members, 44
- 3.2 Planning the Technology Forecast, 46
- 3.3 Team Organization, Management, and Communications, 47
 - 3.3.1 Organizing and Managing the Technology Forecast, 50
 - 3.3.2 Communications, 54
 - 3.3.3 Summary Conclusions about Project Management and Organization, 55
- 3.4 Success: The Right Information at the Right Time, 56
- 3.5 Project Scheduling, 57
 - 3.5.1 Program Evaluation and Review Technique (PERT), 58
 - 3.5.2 Gantt Chart, 60
 - 3.5.3 Project Accountability Chart (PAC), 60
 - 3.5.4 Project Scheduling Software, 61
- 3.6 Conclusions, 62
 - References, 62

4 Exploring 65

- 4.1 Establishing the Context—the TDS, 65
 - 4.1.1 Societal and Institutional Contexts, 66
 - 4.1.2 Technology Context, 67
 - 4.1.3 Stakeholders, 68
 - 4.1.4 Understanding the TDS, 69
 - 4.1.5 An Example TDS Model, 70

4.2	Monitoring, 72	
4.2.1	Why Monitor?, 74	
4.2.2	Who Should Monitor?, 75	
4.2.3	Monitoring Strategy, 76	
4.2.4	Monitoring Focused on Management of Technology Issues, 79	
4.2.5	Monitoring Focused on the Stage of the Technology Development, 81	
4.3	The Stimulation of Creativity, 81	
4.3.1	Five Elements of Creativity, 81	
4.3.2	Group Creativity, 92	
4.4	Conclusion, 95	
	References, 95	
5	Gathering and Using Information	98
5.1	Expert Opinion, 99	
5.1.1	Selecting Experts, 99	
5.1.2	Selecting Expert Opinion Techniques, 100	
5.2	Gathering Information on the Internet, 105	
5.2.1	Science and Technology on the Internet, 106	
5.2.2	Society and Culture on the Internet, 109	
5.3	Structuring the Search, 113	
5.4	Preparing Search Results, 116	
5.5	Using Search Results, 117	
5.6	Developing Science, Technology, and Social Indicators, 119	
5.6.1	Science and Technology Indicators, 119	
5.6.2	Social Indicators, 122	
5.7	Communicating Search Results, 122	
5.8	Conclusions, 123	
	References, 124	
6	Analyzing Phase	129
6.1	Perspective on Data and Methods, 129	
6.1.1	Overview and Caveats, 130	
6.1.2	Internet Time Series Data and Trends, 132	
6.1.3	Analytical Modeling, 133	
6.2	Linear Regression and Extensions, 134	
6.3	Growth Models, 138	
6.3.1	The Models, 138	
6.3.2	Dealing with the Data, 143	

x CONTENTS

- 6.3.3 Regression and Growth Modeling: What Can Go Wrong?, 144
- 6.4 Simulation, 145
 - 6.4.1 Quantitative Cross-Impact Analysis, 146
 - 6.4.2 Qualitative Cross-Impact Analysis, 152
- 6.5 Monte Carlo Simulation, 153
 - 6.5.1 Generating and Displaying Random Values, 153
 - 6.5.2 Sampling Multiple Random Variables, 154
 - 6.5.3 RFID Application in a Hospital Decision, 156
- 6.6 System Dynamics, 158
 - 6.6.1 The System Dynamics Modeling Cycle, 159
 - 6.6.2 A Technology Forecasting Example: The Cable-to-the-Curb Model, 162
- 6.7 Gaming, 164
 - 6.7.1 Decision Trees, 165
 - 6.7.2 Bayesian Estimation, 166
 - 6.7.3 Value of Information, 167
 - 6.7.4 Real Options Analysis, 169
- 6.8 Software Suggestions, 170
 - 6.8.1 Software for Regression, 170
 - 6.8.2 Simulation Analysis Software, 170
 - 6.8.3 Software for Analysis of Decisions, 170
 - 6.8.4 Real Options Super Lattice Software, 170
 - 6.8.5 Software Sites, 171
- References, 171

7 Focusing Phase: Using Scenario Analysis 174

- 7.1 Uncertainty, 175
 - 7.1.1 Uncertainty Frameworks, 175
 - 7.1.2 Source and Nature of Uncertainty, 176
 - 7.1.3 Uncertainty and the Adaptive Paradigm, 177
 - 7.1.4 Techniques for Addressing Uncertainty, 177
- 7.2 Scenarios, 178
 - 7.2.1 Steps in Creating Scenarios, 178
 - 7.2.2 Types of Scenarios, 182
- 7.3 Examples and Applications, 184
 - 7.3.1 Scenarios for Renewable Energy Planning, 184
 - 7.3.2 Pervasive Computing Scenarios, 185
 - 7.3.3 Scenarios for Social Change, 186

7.4	Scenarios: Extensions and Advanced Techniques, 187	
7.4.1	Scenarios in Multimethodology Forecasts, 187	
7.4.2	Extensions of Scenario Analysis, 189	
7.5	Conclusions, 191	
	References, 192	
8	Economic and Market Analysis	194
8.1	The Context, 194	
8.1.1	Markets and Innovation, 197	
8.1.2	Technology and Institutions, 199	
8.2	Forecasting the Market, 203	
8.2.1	The Consumer/Customer Marketplace, 204	
8.2.2	Qualitative Techniques for Appraising Market Potential, 206	
8.2.3	A Quantitative Approach—Adoption and Substitution: S-Curve Models, 207	
8.3	Forecasting the Economic Context, 208	
8.3.1	Macroeconomic Forecasting, 209	
8.3.2	Input-Output Analysis, 210	
8.3.3	General Equilibrium Models, 214	
8.3.4	Hedonic Technometrics, 215	
8.4	Forecasting in an Institutional Context, 216	
8.4.1	Institutional Arrangements and the Market, 216	
8.4.2	Game Theory, 218	
8.4.3	Agent-Based Models, 219	
8.5	Conclusion, 219	
	References, 220	
9	Impact Assessment	223
9.1	Impact Assessment in Technology Forecasting, 223	
9.2	Impacts on Technology and Impacts of Technology, 224	
9.3	A Comprehensive Approach to Impact Assessment, 225	
9.4	Impact Identification, 226	
9.4.1	Scanning Techniques, 226	
9.4.2	Tracing Techniques, 227	
9.4.3	Narrowing the Impact Set and Estimating Effects, 229	
9.4.4	A Final Word, 229	

xii CONTENTS

- 9.5 Impact Analysis, 230
 - 9.5.1 Analyzing Impacts on and Impacts of the Technology, 230
 - 9.5.2 Analyzing Technological Impacts, 232
 - 9.5.3 Analyzing Economic Impacts, 234
 - 9.5.4 Analyzing Environmental Impacts, 234
 - 9.5.5 Analyzing Social Impacts, 238
 - 9.5.6 Analyzing Institutional Impacts, 239
 - 9.5.7 Analyzing Political Impacts, 240
 - 9.5.8 Analyzing Legal and Regulatory Impacts, 241
 - 9.5.9 Analyzing Behavioral, Cultural, and Values Impacts, 242
 - 9.5.10 Analyzing Health-Related Impacts, 243
- 9.6 Impact Evaluation, 244
- 9.7 Conclusion, 245
 - References, 245

10 Cost-Benefit and Risk Analysis 248

- 10.1 Opportunity Costs and Choices, 248
- 10.2 Cost-Benefit Analysis, 249
 - 10.2.1 Cost-Benefit Analysis within the Organization, 249
 - 10.2.2 Societal Stake and the Organizational Response, 253
 - 10.2.3 Cost-Benefit Analysis Methods, 260
 - 10.2.4 Economic Value Added, 263
 - 10.2.5 Earned Value Management, 264
 - 10.2.6 The Balanced Scorecard, 265
- 10.3 Accounting for Risk and Uncertainty, 265
 - 10.3.1 Accounting for Risk within Organizations, 265
 - 10.3.2 Accounting for Risk—the Social Dimension, 269
- 10.4 Concluding the Focusing Phase, 273
 - References, 274

11 Implementing the Technology 277

- 11.1 Forecasting Continues, 277
- 11.2 Implementation Issues, 278
- 11.3 Strategic Planning for Technology Implementation, 278
- 11.4 Selecting from among Alternative Implementations of the Technology, 279
 - 11.4.1 Measurement, 282

11.4.2	Interpretive Structural Modeling, 284	
11.4.3	Analytic Hierarchy Process, 285	
11.4.4	Wrap-Up, 286	
11.5	Technology Roadmapping, 286	
11.6	Summary and Concluding Observations, 287	
	References, 287	
12	Managing the Present from the Future	289
12.1	The Overall Approach, 289	
12.2	Selecting Methods and Techniques, 290	
12.2.1	Using the TDS and the Major Families of Techniques, 290	
12.2.2	The 80–20 Rule, 291	
12.3	Alternative Perspectives, 291	
12.4	Learning from Past Forecasts and Assessments, 293	
12.5	Visions, 295	
12.6	A Final Word, 295	
	References, 296	
Appendix A	Case Study on Forecasting Dye-Sensitized Solar Cells	297
A.1	Framing the Case Study, 297	
A.1.1	Characterizing the Technology, 298	
A.1.2	Dye-Sensitized Solar Cells, 299	
A.2	Methods, 299	
A.2.1	Engaging Experts and Multipath Mapping, 299	
A.2.2	Developing the TDS, 300	
A.2.3	Tech Mining (Chapter 5) and Science Overlay Mapping, 304	
A.2.4	Trend Analyses, 310	
A.2.5	Cross-charting and Social Network Analyses, 311	
A.3	The Rest of the Story, 313	
A.3.1	Market Forecasts, 314	
A.3.2	Scenarios, 315	
A.3.3	Technology Assessment, 315	
A.3.4	Further Analyses and Communicating Results, 316	
	References, 316	
Index		319

