MANAGEMENT OF TECHNOLOGY

MANAGING EFFECTIVELY IN TECHNOLOGY-INTENSIVE ORGANIZATIONS

HANS J. THAMHAIN
MANAGEMENT OF TECHNOLOGY
## CONTENTS

**Preface**  xi  

1  **Challenges of Managing in High-Technology**  1  
   1.1 Managing in Today’s High-Tech Business Environment  /  2  
   1.2 MoT Scope and Focus  /  3  
   1.3 Developing a Formal Definition  /  5  
   1.4 The Special Role of Engineering Management  /  7  
   1.5 Global Dimensions  /  8  
   1.6 Impact of Internet and e-Commerce  /  10  
   1.7 Technology and Society  /  11  
   1.8 Future Trends  /  12  
   1.9 Summary of Key Points and Conclusions  /  13  
   1.10 Critical Thinking: Questions for Discussion  /  14  
   1.11 References and Additional Readings  /  14  

2  **Managing in an e-Business World**  16  
   2.1 A Changing Environment  /  18  
   2.2 The Unique Nature of Managing Technology-Based Businesses  /  19  
   2.3 History of Managing Technology  /  25  
   2.4 Forces That Drive Technology Companies Today  /  27  
   2.5 Measuring Technology Content and Intensity  /  30  
   2.6 Case Study: Reprogramming Amazon  /  32  
   2.7 Summary of Key Points and Conclusions  /  37  
   2.8 Critical Thinking: Questions for Discussion  /  37  
   2.9 References and Additional Readings  /  38
CONTENTS

3 Organizing the High-Technology Enterprise 40
  3.1 Today’s Business Processes Require Flexibility, Speed, and Efficiency / 41
  3.2 Organization Designs for Technology-Based Enterprises / 42
  3.3 Organizational Layers and Subsystems / 44
  3.4 Organizational Choices / 46
  3.5 Real-World Hybrids / 54
  3.6 Understanding the Working Environment / 55
  3.7 Summary of Key Points and Conclusions / 57
  3.8 Critical Thinking: Questions for Discussion / 58
  3.9 References and Additional Readings / 59

4 Concurrent Engineering and Integrated Product Development 61
  4.1 The Need for Effective Management Processes / 63
  4.2 A Spectrum of Contemporary Management Systems / 64
  4.3 Concurrent Engineering—A Unique Project Management Concept / 64
  4.4 Criteria for Success / 66
  4.5 Defining the Process to the Team / 68
  4.6 Understanding the Challenges / 70
  4.7 Understanding the Organizational Components / 71
  4.8 Recommendations for Effective Management / 73
  4.9 Conclusion / 79
  4.10 Summary of Key Points and Conclusions / 80
  4.11 Critical Thinking: Questions for Discussion / 82
  4.12 References and Additional Readings / 82

5 Managing People and Organizations 86
  5.1 Changing Roles of Managerial Leadership / 87
  5.2 Motivation and Technology Performance / 90
  5.3 Formal Models of Motivation / 101
  5.4 Leadership in Technology / 110
5.5 The Power Spectrum in Technology Management / 119
5.6 How to Make It Work: Suggestions for Increasing Effectiveness / 123
5.7 Summary of Key Points and Conclusions / 128
5.8 Critical Thinking: Questions for Discussion / 129
5.9 References and Additional Readings / 130

6 Managing Technology-Based Projects 133

6.1 Management of Technology Is Project-Oriented / 135
6.2 Modern Project Management: A Continuously Evolving System / 137
6.3 The Formal Project Management System / 141
6.4 Framing the Project / 143
6.5 Defining the Work / 147
6.6 Managing Time and Resources / 150
6.7 Defining the Project Organization / 163
6.8 Using Project Management Tools Properly / 166
6.9 A Model for Project Performance / 167
6.10 Summary of Key Points and Conclusions / 168
6.11 Critical Thinking: Questions for Discussion / 169
6.12 References and Additional Readings / 170

7 Measuring and Controlling the Work 172

7.1 The Challenges of Managerial Control in Technology / 173
7.2 What We Know About Managerial Controls in Complex Work Environments / 176
7.3 Characteristics of Effective Controls / 186
7.4 How Do Managers Contol Technology-Intensive Work? / 187
7.5 Recommendations for Using Management Controls Effectively / 194
7.6 Conclusion / 197
7.7 Summary of Key Points and Conclusions / 198
7.8 Critical Thinking: Questions for Discussion / 200
7.9 References and Additional Readings / 200

Appendix: Project Complexity Metrics / 203
CONTENTS

8 Project Evaluation and Selection
  8.1 Making the Right Decisions Up Front / 206
  8.2 Quantitative Approaches to Project Evaluation and Selection / 209
  8.3 Qualitative Approaches to Project Evaluation and Selection / 214
  8.4 Recommendations for Effective Project Evaluation and Selection / 215
  8.5 Summary of Key Points and Conclusions / 218
  8.6 Critical Thinking: Questions for Discussion / 219
  8.7 References and Additional Readings / 220

Appendix: Summary Description of Terms, Variables, and Abbreviations Used in This Chapter / 222

9 Leading Technology Teams
  9.1 Challenges of Technical Teamwork / 225
  9.2 What We Know About Technology-Oriented Teams / 228
  9.3 Toward Self-Direction and Virtual Teams / 230
  9.4 Measuring Project Team Performance / 232
  9.5 A Model for Team Building / 235
  9.6 Building High-Performing Teams / 237
  9.7 Recommendations for Effective Team Management / 239
  9.8 Summary of Key Points and Conclusions / 244
  9.9 Critical Thinking: Questions for Discussion / 245
  9.10 References and Additional Readings / 246

Appendix: Field Research Summary on Team Leadership / 249

10 Managing R&D and Innovation
  10.1 The Need for Innovation in Business: Changes and Challenges / 257
  10.2 What We Know About Management of Technical Innovation / 258
  10.3 Measuring Innovative Performance / 262
  10.4 Characteristics of an Innovative Work Environment / 266
  10.5 Managing for Innovative Performance / 266
  10.6 Conclusions / 269
  10.7 Summary of Key Points and Conclusions / 271
10.8 Critical Thinking: Questions for Discussion / 272
10.9 References and Additional Readings / 273
Appendix: Voices from the Field: Some Applied Research / 277

11 Managing Environmental Quality  280
11.1 New Standards and Policies toward Environmental Quality / 282
11.2 Importance of Cost Accountability to Environmental Quality / 285
11.3 The Established Environmental Cost Accounting System / 287
11.4 New Concepts of Environmental Quality Management in Technology Firms / 295
11.5 Benefits and Challenges of the New Approach / 296
11.6 Criteria for Managing Environmental Quality Effectively / 297
11.7 Conclusions / 299
11.8 Summary of Key Points and Conclusions / 300
11.9 Critical Thinking: Questions for Discussion / 302
11.10 References and Additional Readings / 303

12 Managing Risks in High Technology  306
12.1 The High Stakes of Playing in Technology / 307
12.2 How Managers Deal with Risks—Some Field Research Findings / 308
12.3 Criteria for Effective Risk Management / 314
12.4 Conclusion / 316
12.5 Summary of Key Points and Conclusions / 317
12.6 Critical Thinking: Questions for Discussion / 318
12.7 References and Additional Readings / 319

13 Developing New Business  321
13.1 The Importance of New Business Development / 322
13.2 Proposal Solicitation / 324
13.3 Proposal Types and Formats / 325
13.4 Identifying New Business Opportunities / 326
13.5 Assessing New Contract Opportunities / 327
13.6 Writing a Winning Proposal / 332
CONTENTS

13.7 Negotiating and Closing the Contract / 337
13.8 Recommendations to Management / 338
13.9 Summary of Key Points and Conclusions / 340
13.10 Critical Thinking: Questions for Discussion / 341
13.11 Reference Material and Contract Information Sources / 342

14 Consulting in Technology Management 345

14.1 The Need for Technology Management Consultants / 346
14.2 Criteria for Effective Consulting Services / 348
14.3 A Model for High Performance / 349
14.4 Recommendations to Consulting Professionals / 350
14.5 Conclusions / 353
14.6 Summary of Key Points and Conclusions / 354
14.7 Critical Thinking: Questions for Discussion / 355
14.8 References and Additional Readings / 355

Appendix 1: Policy and Procedure Examples for Management of Technology 357
Appendix 2: Professional Societies in Science, Engineering, and Technology Management 363
Appendix 3: Professional Journals in Engineering and Technology Management 367
Appendix 4: Professional Conferences in Engineering and Technology Management 370
Appendix 5: Centers of Technology Management and Other Resources 372
Index 375
The magnitude and speed of technological advances over the past decades are stunning, reshaping our world and influencing virtually every aspect of life. This current rate of change is not likely to slow down any time soon. From a business perspective, technology is the catalyst that creates wealth. It also lowers the barriers to market entry and levels the competitive playing field for virtually any business, from technical products to medical and financial services to transportation and retailing.

As the important role of technology is being realized, business leaders are under great pressure to leverage technology to obtain better, faster, and cheaper results, gaining sustainable competitive advantages.

Time after time, managers have told me that the biggest challenge they face is not so much in understanding and applying technology, but in integrating and transferring technologies into marketable products, services, and processes that add value to the enterprise. This requires specialized skills in planning, organizing, and guiding multidisciplinary activities. It also requires a great deal of people skills in building cross-functional teams and leading them toward desired results. This involves effective motivation, power and resource sharing, communication both vertically and horizontally, and conflict management. To get results, technology managers must be social architects who understand the culture and value system of the enterprise, and can relate socially as well as technically. The days of managers who get by with only technical expertise or pure administrative skills are gone.

This book is written from the technical manager’s perspective, for managers and professionals who must function effectively in technology-oriented business environments, such as R&D, product development, operations, marketing, and field services. As technology crosses virtually all levels and all disciplines of an enterprise, the principles of managing in technology are relevant not only in engineering and R&D, but also in any organization or business that must effectively deal with the application, integration, and transfer of technology. Financial institutions, hospitals, and law enforcement are just a few examples of the vast array of organizations outside the traditional engineering-scientific community that see themselves as high-technology enterprises.

In addition to the objective of professional reference, this book also is designed as a text for college courses in technology management. It integrates today’s contemporary management practices with the emerging body of knowledge on management of technology, which is further linked with the contemporary concepts of organizational behavior. Managers and technology-oriented professionals at all levels should find this text useful in gaining an understanding of the organizational process, organizational dynamics, and critical success factors that drive technology-based business
performance. Such insight can help in fine-tuning leadership style, resource allocation, and organizational developments, hence continuously improving the enterprise’s ability to compete effectively in today’s complex global markets.

The book also includes my findings of 10 years of formal field research in the area of engineering and technology management. It further integrates the observations and experiences of my 20 years of R&D and technology management with ITT, Westinghouse, General Electric, and GTE/Verizon prior to my current teaching and research career.

I would like to express my appreciation to the many colleagues who encouraged and nurtured the development of this book. Special thanks go to the large number of professionals who contributed valuable information via the formal field research which is summarized in this book.

Waltham, Massachusetts

Hans J. Thamhain

January 2005
Today, Hughes Electronics, a unit of General Motors, is a successful part of the communications revolution. The company designs, manufactures, and markets advanced electronic systems, including telecommunications equipment, offering digital television entertainment and information programming via satellite. Hughes operates a network of satellites, including DIRECTV, the largest US direct broadcast satellite (DBS) system, marketed via PanAmSat Corporation, offering 150 channels of movies, cable TV programs, and sporting events directly to anyone in the United States, Canada, and part of South America. Hughes had secured part of this market niche already in 1997 by forming an alliance between its PanAmSat subsidiary and SatMex (Satellites Mexicanos) to bid for an additional strategic satellite position. Other bidders included Primestar and EchoStar. At 77 degrees west longitude the Mexican slot was the last to allow a satellite to beam full conus coverage of the United States and Mexico.

The direct broadcast satellite (DBS) ventures are part of the world’s most complex, but also fastest growing businesses. Today, DIRECTV/Hughes markets its services through PanAmSat to more than 10 million subscribers with annual revenues of nearly $7 billion. For Hughes Electronics, a subsidiary of General Motors, this new business started 15 years ago, when the Federal Communications Commission (FCC) set aside part of the radio spectrum for...