CONTENTS

List of Figures x		XV
Acknowledgments		xvii
Chapter 1	Introduction	1
	 1.1 The Retention of Software Jobs 2 1.2 Depth of Experience 2 1.3 The Scope of This Book 3 1.4 The Nature of Computer Science 4 1.5 The Future of Computer Science 4 1.6 The Essence of Philosophy 5 1.7 Why Autonomy? 6 1.8 An Architecture for Autonomy 8 1.9 Other Notes 9 	
Chapter 2	Prologue	11
	 2.1 How This Book Originated 11 2.2 The Importance of Management 12 2.3 The Tie-in with Autonomy 13 2.4 Major Themes of This Book 14 2.5 The Challenge of a New Idea 14 2.6 The Importance of Visualization 15 2.7 The Move Toward Autonomy 16 2.8 Why I Wrote This Book 17 2.9 Merging Theory and Practice 18 2.10 The Pace of Computer Science 19 2.11 The Importance of Cognitive Dynamics 21 	
Chapter 3	The Philosophical Foundations of Computer Software Design	23
	 3.1 The Philosophical Origins of Computer Science 23 3.2 Influence of the Cognitive Philosophers 25 3.3 Abstracting the Human Thought System 27 3.4 The Philosophical Foundations of Software Development 28 3.5 The Phenomenon of Reality 29 	

- 3.6 The Phenomenon of Subjectivity 30
- 3.7 Low-Cost Software Development 31
- 3.8 "On Budget and On Schedule" 33
- 3.9 The Time to Completion: Schedule 34
- 3.10 Philosophy and Successful Design 35

Chapter 4 The Philosophical Imperatives of Architectural Design

36

54

- 4.1 The Manager as Architect 36
- 4.2 The Manager as Teacher 37
- 4.3 The Manager as Social Worker 38
- 4.4 The Manager as Axman 39
- 4.5 The Philosophical Imperatives of Architectural Design 39
- 4.6 Availability of the Manager 40
- 4.7 Project Manager: 10 Key Attributes and Responsibilities 40
- 4.8 Philosophical Aspects of Engineering 43
- 4.9 The Importance of Finishing the Job 44
- 4.10 Visualizing an Architecture 44
- 4.11 The Role of Intuition in Design 47
- 4.12 "Sufficient Reality" and Inference in the Design Process 48
- 4.13 Dialectics in the Achievement of Sufficient Reality 49
- 4.14 The Relationship of Logic to Software Architectures 50
- 4.15 The Logic of the Systems Design 53

Chapter 5 Project and Task Organization

- 5.1 The Role of Organization 55
- 5.2 The Ability to Organize 57
 - 5.2.1 Traditional Hierarchical Project Organization 57
- 5.3 The Difficulty of Communication 60
- 5.4 The Title of "Manager" 61
- 5.5 The Flat, Nonhierarchical Organization 61
- 5.6 Projects, Tasks, and Work Units 65
- 5.7 Large Organizations and Staffing 66
- 5.8 Staffing Up: The Initial Team 69
 - 5.8.1 The Initial Team 69
 - 5.8.2 Phase One Team Expansion 70
 - 5.8.3 Phase Two Team Expansion 72
- 5.9 Balancing Hardware and Software 73
- 5.10 Incremental Deliveries 75
- 5.11 Functional Organization 76
- 5.12 Interface Protocols of the Organization 77

	5.13 Completion of the Task 775.14 Detecting the "Fraud" 78	
Chapter 6	The Philosophy of Communication	80
	 6.1 "Sanity Is an Achievement!" 81 6.2 Gauging Understanding 82 6.3 Internal Team Communication Protocols 82 6.4 External Team Communication Protocols 84 6.5 Technical English as the Medium 85 6.6 Engineers as Technical Writers 87 6.7 Documentation: Articulation of the Requirements and Design 87 6.8 The SRD: Software Requirements Document 88 	
Chapter 7	Software Management Standards	91
	 7.1 Three Good Standards 91 7.1.1 JPL-STD-D-4000 92 7.1.2 MIL-STD-498 92 7.1.3 DOD-STD-2167A 92 7.2 Aspects Addressed by a Standard 93 7.3 Preparing to Select the Standard 94 7.4 Standards for Implementation 96 7.4.1 Waiving the Standard 97 	
Chapter 8	The Estimation of Software Cost	98
	 8.1 Sponsor Costing Issues 99 8.2 Types of Cost Estimates 101 8.3 "Lines of Code" Metrics 101 8.4 The Major Work Areas, Functions, and Tasks that Must be Included in the Estimation of Cost 103 8.5 The Detailed Cost Estimate 105 8.6 The SRD as a Contract 106 	
Chapter 9	The Exercise of Project Control	108
	 9.1 The Functions of Project Control and Oversight 109 9.2 The Requirements Phase 110 9.3 Contents of the Software Requirements Document 111 9.4 The Design Phase 113 9.5 The Implementation Phase 113 9.6 The Test and Integration Phase 115 9.7 Personnel Issues 116 9.8 The Hacker and Other Personalities 118 9.9 The Buck Stops at the Top 119 9.10 How People Think, Pay Attention, and Remember 121 	

Chapter 10	The Development Process Methodology	125
	 10.1 The "Design Hub" as Implementation Tool 126 10.2 The Architecture Definition Process 127 10.3 The Use of Large-Scale Representations 129 10.4 Design Team Meetings 130 10.5 Rapid Development versus Prototyping 131 10.6 The Traditional Development Methodology 132 10.7 Action Items, Change Requests, and Software Discrepancy Reports 134 10.8 Resolving Problems and Impasses 134 	
Chapter 11	The Development of System Architectures	136
	 11.1 Pushing the Architecture 137 11.2 The Point of "Acceptable Reality" 138 11.3 The Importance and Imperative of Visualizing Phenomena 140 11.4 Traditional Architectures 141 11.5 The Inferred Architecture 142 11.6 The Redesign or Upgrading of Existing Systems 144 11.7 The Approach to New Systems 145 	
Chapter 12	The Impact of Leadership on Software Development	146
	 12.1 Recognizing Good Leadership 146 12.2 The Concepts of Management and Leadership 148 12.3 Rewarding Failure 149 12.4 The Leader's Subordinate 151 12.5 Indications of Poor Leadership 152 12.6 Leadership and Ethics 153 12.7 The Attributes of Leadership 153 12.7.1 Unselfishness 154 12.7.2 The Welfare of Others 154 12.7.4 Integrity 154 12.7.5 Loyalty 155 12.7.6 Knowledge 155 12.7.7 Tact 156 12.7.8 Judgment 157 12.7.10 Bearing 158 12.7.11 Courage 158 12.7.12 Decisiveness 159 	

	 12.7.13 Dependability 159 12.7.14 Dynamic Energy 160 12.7.15 Enthusiasm 161 12.7.16 Empowerment 163 12.8 The Ramifications of Failure 164 12.9 The Absence of Leadership 165 12.9.1 Absenteeism 166 12.9.2 Hidden Agendas 166 12.9.3 Communication Gap 167 12.9.4 Poorly Defined Goals 167 	
	12.10 The Basis in Leadership for Failure 16812.10.1 Personal Struggles 16812.10.2 The "Machiavellian Prince" 169	
	12.11 The impact of Poor or Nonexistent Leadership 16912.11.1 Conquering the Organization 170	
Chapter 13	Management of Software Systems Development	172
	 13.1 Self-Respect in the Manager 173 13.2 The Ethical Workplace 173 13.3 Narcotics Use in the Workforce 174 13.4 Spotting Narcotics Addicts 177 13.5 Courage and Dynamic Energy in Management 178 13.6 The Traveling Manager 180 13.7 The Manager as Architect 181 13.8 The Phenomenon of Decision Making 182 13.9 The Concept of "Ability" 186 13.10 Manager: Administrator or Leader? 187 13.11 Authority, Responsibility, and Accountability 189 13.12 The Issue of Contempt 189 13.13 Management: The Fulcrum of Project Execution 191 13.15 The Pitfalls of Staffing Up 193 13.16 Salary Issues 195 13.17 Contracting Out Work 196 13.18 Evaluating Proposals 197 13.19 Cost Bidding too Early 198 	
Chapter 14	Four Case Studies of Low-Cost Systems	200
	14.1 Case Study One: The Joint Theater Level Simulation (JTLS) 202	
	14.1.1 The Beginnings of JTLS 20414.1.2 Estimating the Cost of War 205	

xi

- 14.1.3 Starting up the Effort 208
- 14.1.4 Costly Lessons Learned 209
- 14.2 Case Study Two: The Global Decision Support System (GDSS) 211
 - 14.2.1 GDSS System Size 211
 - 14.2.2 The History and Background of GDSS 212
 - 14.2.3 Expediting the System 213
 - 14.2.4 The Euler Sphere 214
 - 14.2.5 Beyond State of the Art 214
 - 14.2.6 A Replicated, Survivable, Synchronous Database Management System 214
 - 14.2.7 The Ultra Large Screen Display System 215
 - 14.2.8 The Local Area Networks 215
 - 14.2.9 The Wide Area Network 215
 - 14.2.10 Distributed Client/Server Technology 215
 - 14.2.11 Message Bus 215
 - 14.2.12 The GDSS Software Architecture 217
 - 14.2.13 Accepting the Challenge 220
 - 14.2.14 Initial Conditions 220
 - 14.2.15 Rapid Development: A Totally Different Approach 221
 - 14.2.16 There Can Be Only One! 223
 - 14.2.17 GDSS End-to-End Architecture 224
 - 14.2.18 Architecting the Development Effort 224
 - 14.2.19 Inferential Systems Architecture 225
 - 14.2.20 The GDSS System Software Layer 226
 - 14.2.21 Applications Language Selection 227
 - 14.2.22 Project Documentation 228
 - 14.2.23 Finding an Ada Expert 228
 - 14.2.24 Testing and Database Design 229
 - 14.2.25 Additional Difficulties 231
- 14.3 Case Study Three: The Topex TCCS System 233
 - 14.3.1 The Topex TCCS System 233
 - 14.3.2 System Description 233
 - 14.3.3 The Initial Conditions 235
 - 14.3.4 Project Constraints 235
 - 14.3.5 Implementation Considerations 236
 - 14.3.6 Development of TOPEX TCCS 237
 - 14.3.7 Agreeing to Do the Job 238
 - 14.3.8 Ground Truth 239
 - 14.3.9 Start of Project Development 239
 - 14.3.10 Architecting the Environment 241
 - 14.3.11 Hardware Procurement, Software Procurement 242
 - 14.3.12 The Relationship with the Contractor 244

14.3.13 Test Plan Scheduling 245

14.3.14 Adherence to a Standard 246

- 14.4 Case Study Four: The Jason 1 TCCS System (JTCCS) 246
 - 14.4.1 The Jason 1 TCCS System 247
 - 14.4.2 System Description 247
 - 14.4.3 The Initial Conditions 248
 - 14.4.4 Implementation Considerations 249
 - 14.4.5 The JTCCS Architecture 251

Chapter 15 Operations, Operators, and Users: Their Impact on Cost

257

266

- 15.1 The Operational Requirement 258
- 15.2 The Lack of an Operational Requirement 259
- 15.3 The Operations Scenario 259
- 15.4 The Cost of Operators and Analysts 260
- 15.5 The Voyager Project Operations Center 261
- 15.6 War Gaming 262
- 15.7 The Value of Simulation 264
- 15.8 Funds: A Perspective 264

Chapter 16 The Autonomous Cognitive System

- 16.1 Introduction 266
- 16.2 The Scale of Autonomy 267
 - 16.2.1 Category IV Autonomous Cognitive System: Superman 267
 - 16.2.2 Category III Autonomous Cognitive System: Perseus 268
 - 16.2.3 Category II Autonomous Cognitive System: Robot 269
 - 16.2.4 Category I Autonomous Cognitive System: Automaton 269
- 16.3 "I Will, Because I Can" 270
- 16.4 Toward Cognitive Dynamics 271
- 16.5 Building an Autonomous System 271
- 16.6 An Appropriate Model 272
- 16.7 System-Level Requirements for Autonomy 273
- 16.8 Architectural Domains for Autonomy 274
 - 16.8.1 Domain I: The Human Thought Architecture Model (Functional Architecture) 274
 - 16.8.2 Domain II: The Human Thought Process Model (Common Software Services) 275
- 16.9 In Summary 277

Epilogue

The Science of Computer Science 279		
The Professional Software Manager 279		
Cognitive Philosophy in a Modern Technical Context	280	
Cognitive Dynamics is the Unifying Theory 281		
The Issue of Software Cost 281		
The Paradigm Shift of Cognitive Dynamics 282		
A		202

Glossary of Acronyms

Index

283

279

LIST OF FIGURES

Figure 1	Computer Science Architectural Interpretation of
i igui e i	Kantian Philosophy
Figure 2	The Requirements and Design Process: Dialectically Achieving "Sufficient Reality"
Figure 3	Project Organization: Traditional Hierarchical Approach: Isolated Control
Figure 4	Project Organization: Flat, Nonhierarchical Approach: Optimal Control (Front View)
Figure 5	Project Organization: Flat, Nonhierarchical Approach: Optimal Control (Overhead)
Figure 6	Estimation of Software Cost: Software Work-Estimation Worksheet
Figure 7	Two General Approaches to System Development: Known & Unknown Requirements
Figure 8	The Kantian Thought Process: Decision-Making Schema
Figure 9	Joint Theater Level Simulation: Operating System-dependent Architecture
Figure 10	Global Decision Support System: Wide Area Network Configuration
Figure 11	Global Decision Support System: Integrated Software Functional Design
Figure 12	Global Decision Support System: Official Memo of Recognition
Figure 13	Topex/Poseidon TCCS Software Architecture
Figure 14	The Topex War Room: The Design Hub as an Implementation Environment
Figure 15	JASON-1 TCCS Software Architecture
Figure 16	JASON-1 TCCS Pluggable Architecture

Figure 17 JASON-1 TCCS User Interface Client/Server Architecture