A low-angle, upward-looking photograph of a roller coaster track. The track is made of dark metal and forms a large, circular loop that dominates the frame. The sky is visible through the center of the loop, showing a blue color with scattered white clouds. The perspective creates a sense of height and scale.

PROJECT MANAGEMENT FOR ENGINEERING, BUSINESS AND TECHNOLOGY

JOHN M. NICHOLAS AND HERMAN STEYN

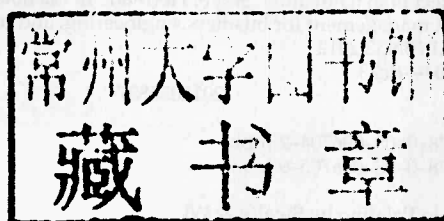
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Project Management for Engineering, Business and Technology

F O U R T H E D I T I O N

John M. Nicholas
Loyola University Chicago

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University of Pretoria



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Project Management for Engineering, Business and Technology

There is an ever-growing need for better project management within the disciplines of engineering, business, and technology and this new edition is a direct response to that need. By emphasizing practical applications, this book targets the ultimate purpose of project management: to unify and integrate the interests, resources, and work efforts of many stakeholders to accomplish the overall project goal.

The book encompasses the essential background material required, from philosophy to methodology, before presenting concepts and techniques for practical application on topics including:

- Project initiation and proposals
- Scope and task definition
- Scheduling
- Budgeting
- Risk analysis

The new edition has been updated to provide closer alignment with PMBOK terms and definitions for more ease of use alongside PMI qualifications and covers the latest developments in project management methodologies.

Supplemented by brand new case studies from engineering and technology projects, as well as improved instructor support materials, this text is an ideal resource and reference for anyone studying or practicing project management within business or engineering environments.

John M. Nicholas is Professor of Operations and Project Management and former Associate Dean of the Graduate School of Business at Loyola University, Chicago, USA. He is an active teacher, writer, and researcher in project management and manufacturing management, conducting executive seminars and consults on project management and process improvement. He has authored numerous academic and technical publications and led or worked on projects for companies such as Lockheed-Martin Corporation, Bank America, and Argonne National Laboratory.

Herman Steyn is Professor at the Graduate School of Technology Management, University of Pretoria, South Africa where he specializes in project management, initiating currently the only master's program in Project Management on the African continent that is accredited by the PMI (USA). He has been involved in project management in industry since 1975 and has managed a variety of engineering projects (system, product, and process development) in the minerals, defence, and nuclear industries. He has also managed product portfolios.

INTRODUCTION 1

To Sharry, Julia, Joshua, Abigail, and Wilma
J.M.N.

To Karen and Janine
H.S.

PART I: PHILOSOPHY AND CONCEPTS 17	1
1.1 The Project and the Project Cycle 17	1
1.2 Project and System Definition 17	1
1.3 Systems Development Cycle and Project Conception 83	83

PART II: SYSTEMS DEVELOPMENT CYCLE 83

2.1 Planning Fundamentals 183	2
2.2 Project Time Planning and Network 187	2
2.3 Advanced Project Network Analysis and Scheduling 237	7
2.4 Cost Estimating and Budgeting 281	8
2.5 Project Quality Management 321	9
2.6 Managing Risks in Projects 351	10
2.7 Project Execution and Control 383	11
2.8 Project Termination, Communication, Implementation, and Closure 435	12

PART III: SYSTEMS AND PROCEDURES FOR PLANNING AND CONTROL 181

3.1 Project Organization Structure and Integration 463	13
3.2 Project Roles, Responsibility and Authority 497	14
3.3 Managing Participation, Teamwork, and Conflict 523	15

PART IV: ORGANIZATION BEHAVIOR 463

4.1 The Management of Project Management 553	16
4.2 Project Selection and Portfolio Management 573	17
4.3 International Project Management 593	18

INDEX 593

PREFACE

When people see something impressive—a bridge arching high over a canyon, a space probe touching down on a distant planet, a curlicue ramp on a freeway, a motion picture so realistic you think you're there, or a nifty computer the size of your hand—they sometimes wonder, "How did they do that?" By *they*, of course, they are referring to the creators, designers, and builders, the people who thought up and actually made those things. Seldom do they wonder about the *managers*, the people who organized and led the efforts that brought those astounding things from a concept or idea to reality, and without whose talent, skills, and hard work most neat ideas would never amount to anything. This book is about the managers—project managers, the mostly unsung heroes of engineering, business, and technology who stand outside the public eye but are behind practically every collective effort to create, develop, or produce something.

Although the project manager is but one of many people involved in the creation of each of society's products, systems, and artifacts, he or she is usually the one who gets all of the others involved and then organizes and directs their efforts so everything will come out right. Sometimes, though rarely, the manager and the creator happen to be the same: Burt Rutan, Woody Allen, and Gutzon Borglum are examples; their life work—in aerospace, motion pictures, and monumental sculptures, respectively—represents not only creative or technological genius, but leadership and managerial talent as well.

The past few decades have seen businesses expand from domestic, nationalistic enterprises and markets into multinational, global enterprises and markets. As a result, no matter what your perspective, there is more of everything to contend with—more ideas, competitors, resources, constraints, and, certainly, more people doing and wanting things. The rate of technological change is accelerating, and products and processes are evolving at a more rapid pace; as a result, the life cycles of most things society desires or relies upon are getting shorter. This "more of everything" has had a direct impact on the conduct of projects—including projects to develop products, systems, or processes that compete in local, domestic, and international markets; projects to create and implement new ways of meeting demand for energy, recreation, housing, communication, transportation, and food; and projects to answer basic questions in science and resolve problems such as hunger, disease, pollution, and the consequences of natural disasters. All of this project activity has spurred a growing interest in project management and ways to plan, organize, and control projects to better meet the needs of customers, markets, and society within the bounds of limited time and resources.

Associated with this interest is the growing need to educate and train project managers. In the past, project managers were chosen for some demonstrated exceptional capability, although not necessarily managerial—and this is still the case today. If you were a good engineer, systems analyst, researcher, architect, or accountant, eventually you would become a project manager. Somewhere along the way, presumably, you would pick up the "other" necessary skills. The flaw in this reasoning is that project management encompasses a broad range of skills—managerial, leadership, interpersonal—that are much different than and independent of skills associated with

technological competency. And there is no reason to presume that the project environment alone will provide the opportunity for someone to “pick up” these other necessary skills.

As a text and handbook, this book is about the “right” way to manage projects. It is intended for advanced undergraduate and graduate university students, and for practicing managers in engineering, business, and technology. As the title says, it is a book about principles *and* practice, meaning that the topics in it are practical and meant to be applied. It covers the big picture of project management—origins, applications, and philosophy—as well as the nitty-gritty, how-to steps. It describes the usual project management topics of schedules, budgets, and controls, but also the human side of project management, including leadership and conflict.

Why a book on project management in engineering, business, *and* technology? In our experience, technical specialists such as engineers, programmers, architects, chemists, and so on, often have little or no management training. This book, which includes many engineering and technology project examples, provides somewhat broad exposure to relevant business concepts and management specifics to help these specialists get started as managers.

What about those people involved in product development, marketing, process improvement, and related projects commonly thought of as “business projects”? Just as students of engineering and technology seldom receive formal management training, business students are rarely exposed to common practices in technology projects. This book reveals not only how “business” projects are conducted, but also concepts and necessary steps in the conception and execution of engineering, product development, construction, and other “technology” projects. Of course, engineering and technology projects are *also* business projects; they are conducted in a business context, and involve business issues such as customer satisfaction, resource utilization, deadlines, costs, profits, and so on.

Virtually all projects—engineering, technology, and business—are originated and conducted in similar ways, conceptualized in this book using a methodology called the Systems Development Cycle (SDC). The SDC serves as a general framework for discussing the principles and practices of project management, and illustrating commonalities and differences among a wide variety of projects.

This book is an outgrowth of our combined several decades of experience teaching project management at Loyola University Chicago and the University of Pretoria to business and engineering students, preceded by several years working in business and technology projects, including aircraft design and flight-test projects, large-scale process facility construction projects, and software applications development and process improvement projects. From our practical experience, we developed an appreciation not only for the business management side of project management but also for the human and organizational side. We have seen the benefits of good communication, trust, and teamwork, as well as the costs of poor leadership, emotional stress, and group conflict. In our experience, the most successful projects are those where leadership, trust, communication, and teamwork flourish, regardless of the formal planning and control systems in place; this book largely reflects these personal experiences. Of course, comprehensive coverage of the project management field required that we look much beyond our own experience and draw upon the published works of many other authors and the suggestions of colleagues and reviewers.

In this fourth edition we have revised and added material to incorporate new topics of interest, current examples, and the growing body of literature in project management. To ensure compatibility with modern software, the activity-on-node method is used in all scheduling examples, though the activity-on-arrow method is discussed in an appendix to Chapter 6. New material includes additional coverage of

procurement management and the topic of agile project management, as well as 13 new end-of-chapter case studies. Books tend to grow in size with each new edition; to combat that, every chapter has been rewritten to make everything more readable and more concise. Despite the inclusion of new material, this book has fewer pages than the previous edition.

Our goal in writing this book is to provide students and practicing managers with the most practical, current, and interesting text possible. We appreciate hearing your comments and suggestions. Please send them to us at jnichol@luc.edu and herman.steyn@up.ac.za.

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Our wives Sharry and Karen also get special thanks. Sharry provided numerous suggestions to the first edition, and helped reduce the amount of “techno-jargon” in the book; she managed the home front, was a steadfast source of support, and freed up time so that I (John) could pursue and complete this project. Karen provided wifely support and encouragement; as in the case of so many other projects I (Herman) have been involved in, had not it been for her support my contribution to this project would not have materialized.

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John M. Nicholas
Herman Steyn

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BRIEF CONTENTS

INTRODUCTION 1

PART I: PHILOSOPHY AND CONCEPTS 17

- 1 What Is Project Management? 19
- 2 Systems Approach and Systems Engineering 46

PART II: SYSTEMS DEVELOPMENT CYCLE 83

- 3 Systems Development Cycle and Project Conception 85
- 4 Project and System Definition 126

PART III: SYSTEMS AND PROCEDURES FOR PLANNING AND CONTROL 161

- 5 Planning Fundamentals 163
- 6 Project Time Planning and Networks 197
- 7 Advanced Project Network Analyses and Scheduling 237
- 8 Cost Estimating and Budgeting 281
- 9 Project Quality Management 320
- 10 Managing Risks in Projects 351
- 11 Project Execution and Control 389
- 12 Project Evaluation, Communication, Implementation, and Closeout 436

PART IV: ORGANIZATION BEHAVIOR 461

- 13 Project Organization Structure and Integration 463
- 14 Project Roles, Responsibility, and Authority 497
- 15 Managing Participation, Teamwork, and Conflict 523

PART V: PROJECT MANAGEMENT IN THE CORPORATE CONTEXT 551

- 16 The Management of Project Management 553
- 17 Project Selection and Portfolio Management 579
- 18 International Project Management 602

Index 663

CONTENTS

Preface xvii

Acknowledgements xxi

About the Authors xxiii

INTRODUCTION 1

- I.1 In the Beginning . . . 1
- I.2 What Is a Project? 4
- I.3 Project Management: The Need 7
- I.4 Response to Modern Society 8
- I.5 Systems Approach to Management 9
- I.6 Project Goal: Time, Cost, and Requirements 9
- I.7 Project Management: The Person, the Team, the Methodology 10
- I.8 About This Book 11
- I.9 PMBOK 13
- I.10 Study Project Assignment 13
 - Review Questions and Problems 15
 - Notes 16

PART I: PHILOSOPHY AND CONCEPTS 17

CHAPTER 1 What Is Project Management? 19

- 1.1 Functions and Viewpoints of Management 19
- 1.2 Project Viewpoint versus Traditional Management 21
- 1.3 Evolution of Project Management 24
- 1.4 Where Is Project Management Appropriate? 26
- 1.5 Management by Project: A Common Approach 28
- 1.6 Different Forms of Project Management 29
- 1.7 Project Environments 32
- 1.8 Project Management in Industrial Settings 33
- 1.9 Project Management in the Service Sector 36
- 1.10 Project and Program Management in the Public Sector and Government 37
- 1.11 Summary 40
 - Review Questions and Problems 41
 - Questions About the Study Project 41
 - Case 1.1 Disaster Recovery at Marshall Field's 42
 - Case 1.2 Flexible Benefits System Implementation at Shah Alam Medical Center 43
 - Notes 44

CHAPTER 2 Systems Approach and Systems Engineering 46

2.1	Systems Thinking	46
2.2	Definition of System	47
2.3	Systems Concepts and Principles	48
2.4	Organizations and Environment	52
2.5	Systems Approach	53
2.6	Systems Engineering	57
2.7	Relevancy of the Systems Approach to Project Management	61
2.8	Summary	62
	Appendix: Stages of Systems Engineering	63
	Stage 1: Needs Identification and Conceptual Design	63
	Stage 2: Preliminary Design	68
	Stage 3: Detailed Design and System Development	74
	Stage 4: System Fabrication, Construction, and/or Production	75
	Stage 5: System Operation and Support	75
	Review Questions and Problems	77
	Questions About the Study Project	78
	Case 2.1 Glades County Sanitary District	79
	Case 2.2 Life and Death of an Aircraft Development Project	79
	Notes	81

PART II: SYSTEMS DEVELOPMENT CYCLE 83

CHAPTER 3 Systems Development Cycle and Project Conception 85

3.1	Systems Life Cycle	86
3.2	Systems Development Cycle	87
3.3	Phase A: Conception	91
3.4	Project Feasibility	93
3.5	The Project Proposal	102
3.6	Project Contracting	108
3.7	Summary	115
	Appendix: Kinds of Contracts	115
	Variables	116
	Fixed Price Contract	116
	Cost-Plus Contract	117
	Incentive Contract	118
	Review Questions and Problems	120
	Questions About the Study Project	121
	Case 3.1 West Coast University Medical Center	122
	Case 3.2 X-philes Data Management Corporation: RFP Matters	122
	Case 3.3 Proposal Evaluation for Apollo Spacecraft	123
	Notes	124

CHAPTER 4	Project and System Definition	126
4.1	Phase B: Definition	126
4.2	Project Charter	129
4.3	Project Definition	129
4.4	System Definition	133
4.5	Concurrent Engineering	143
4.6	Systems Development in Industry and Government	144
4.7	Summary	149
	Appendix: Quality Function Deployment	149
	House of Quality	150
	QFD Process	152
	Review Questions and Problems	154
	Questions About the Study Project	155
	Case 4.1 Star-Board Construction and Santaro Associates:	
	Requirements Snafu	156
	Case 4.2 Revcon Products and Welbar, Inc.: Client–Contractor	
	Communication	156
	Case 4.3 Lavasoft.com: Interpreting Customer Requirements	157
	Case 4.4 Proposed Gold Mine in Canada: Phased Project Planning	158
	Notes	159

PART III: SYSTEMS AND PROCEDURES FOR PLANNING AND CONTROL 161

CHAPTER 5	Planning Fundamentals	163
5.1	Planning Steps	164
5.2	The Project Master Plan	164
5.3	Scope and Statement of Work	167
5.4	Work Definition	169
5.5	Project Organization and Responsibilities	177
5.6	Scheduling	180
5.7	Planning and Scheduling Charts	181
5.8	Line of Balance	186
5.9	Procurement Management	187
5.10	Summary	191
	Review Questions and Problems	191
	Questions About the Study Project	193
	Case 5.1 Barrage Construction Company: Sean’s WBS	193
	Case 5.2 Startrek Enterprises, Inc.: Deva’s Project Plan	194
	Case 5.3 Walter’s Project Plan	195
	Notes	196

CHAPTER 6 Project Time Planning and Networks 197

6.1	Network Diagrams	198
6.2	The Critical Path	202

6.3	Gantt Charts and Calendar Schedules	210
6.4	Management Schedule Reserve	211
6.5	Types of Precedence Relationships	212
6.6	Scheduling with Resource Constraints	217
6.7	Criticisms of Network Methods	225
6.8	Summary	225
	Summary List of Symbols	225
	Summary Illustration Problem	226
	Appendix I: AOA Diagrams	226
	Dummy Activities	227
	AON versus AOA	228
	Appendix II: Alternate Scheduling Method: Starting the	
	Project at Day 1	228
	Review Questions and Problems	229
	Questions About the Study Project	234
	Case 6.1 Network Diagram for a Large Construction Project	234
	Notes	236
CHAPTER 7	Advanced Project Network Analyses and Scheduling	237
7.1	CPM and Time–Cost Trade-off	237
7.2	Variability of Activity Duration	245
7.3	PERT	246
7.4	Theory of Constraints and Critical Chain Method	255
7.5	Allocating Resources and Multiple Project Scheduling	262
7.6	TOC Method for Allocating Resources to Multiple Projects	265
7.7	Discussion and Summary	269
	Summary List of Symbols	270
	Appendix: The Central Limit Theorem and its Implications	270
	Theorem	270
	Application to PERT	270
	The Principle of Aggregation	272
	Review Questions and Problems	272
	Questions About the Study Project	276
	Case 7.1: Bridgecon Contractors	276
	Case 7.2: The LOGON Project	278
	Notes	279
CHAPTER 8	Cost Estimating and Budgeting	281
8.1	Cost Estimates	282
8.2	Cost Escalation	282
8.3	Cost Estimating and the Systems Development Cycle	287
8.4	Life Cycle Costs	288
8.5	Cost Estimating Process	290
8.6	Elements of Budgets and Estimates	297
8.7	Project Cost Accounting Systems	301

8.8	Budgeting Using Control (Cost) Accounts	303
8.9	Cost Summaries	304
8.10	Cost Schedules and Forecasts	309
8.11	Summary	314
	Review Questions and Problems	315
	Questions About the Study Project	317
	Case 8.1 Life Cycle Costs for Fleet of Tourist Spaceships	318
	Case 8.2 Estimated Tunnel Costs for the Chunnel Project	318
	Notes	319
CHAPTER 9 Project Quality Management		320
9.1	The Concept of Quality	320
9.2	Processes of Project Quality Management	324
9.3	Techniques for Quality Assurance during System Development	328
9.4	Techniques for Quality Control	339
9.5	Summary	343
	Review Questions and Problems	344
	Questions About the Study Project	344
	Case 9.1 Ceiling Panel Collapse in the Big Dig Project	345
	Case 9.2 FIFA 2010 World Cup South Africa	346
	Notes	349
CHAPTER 10 Managing Risks in Projects		351
10.1	Risk Concepts	351
10.2	Risk Identification	353
10.3	Risk Assessment	358
10.4	Risk Response Planning	366
10.5	Risk Tracking and Response	370
10.6	Project Management Is Risk Management	371
10.7	Summary	374
	Appendix: Risk Analysis Methods	375
	Expected Value	375
	Decision Trees	377
	Uncertainty and Payoff Tables	378
	Simulation	380
	Review Questions and Problems	380
	Questions About the Study Project	383
	Case 10.1 The Sydney Opera House	384
	Case 10.2 Infinity & Beyond, Inc.	385
	Case 10.3 The Nelson Mandela Bridge	385
	Notes	387
CHAPTER 11 Project Execution and Control		389
11.1	Phase C: Execution	390
11.2	Design Stage	390

11.3	Production/Build Stage	393
11.4	The Control Process	395
11.5	Work Packages and Control Accounts	398
11.6	Project Control Emphasis	402
11.7	Performance Analysis	407
11.8	Forecasting "To Complete" and "At Completion"	417
11.9	Controlling Changes	421
11.10	Contract Administration	424
11.11	Problems with Controlling Projects	426
11.12	Summary	426
	Summary of Variables	427
	Review Questions and Problems	428
	Questions About the Study Project	430
	Case 11.1 The Cybersonic Project	431
	Case 11.2 SA Gold Mine: Earned Value After a Scope Change	432
	Case 11.3 Project Change Control Process at Dynacom Company	433
	Notes	434

CHAPTER 12 Project Evaluation, Communication, Implementation, and Closeout 436

12.1	Project Evaluation	437
12.2	Project Communication Management	438
12.3	Project Management Information Systems	443
12.4	Implementation Stage	448
12.5	Project Termination and Closeout	450
12.6	Project Summary Evaluation	453
12.7	After the Project—Phase D: Operation	455
12.8	Summary	456
	Review Questions and Problems	457
	Questions About the Study Project	458
	Case 12.1 Status Report for the LOGON Project	459
	Case 12.2 SLU Information Central Building	459
	Notes	460

PART IV: ORGANIZATION BEHAVIOR 461

CHAPTER 13 Project Organization Structure and Integration 463

13.1	Formal Organization Structure	464
13.2	Organizational Design by Differentiation and Integration	465
13.3	Requirements of Project Organizations	467
13.4	Integration of Subunits in Projects	468
13.5	Liaison Roles, Task Forces, and Teams	468
13.6	Project Expeditors and Coordinators	470
13.7	Pure Project Organizations	472
13.8	Matrix Organizations	474