

Contents

List of Figures	ix	
List of Tables.....	xi	
Foreword	xiii	
Preface.....	xv	
About the Authors.....	xvii	
Chapter 1	Introduction	1
	1.1 Development of Modern Systems.....	1
	1.2 Systems Engineering: The Approach in This Book	1
	1.3 Facilitating Multidisciplinary Projects	2
	1.4 Designing a Solar Race Car	3
	1.5 Notes on How to Use This Book	4
Chapter 2	The Systems Engineering Process.....	7
	2.1 Introduction.....	7
	2.2 The Essence of the Systems Engineering Process	7
	2.3 A Practical Implementation of Systems Engineering ...	9
	2.3.1 System Level.....	11
	2.3.2 Subsystem Level	14
	2.3.3 Integration	15
	2.3.4 Verification and Validation.....	17
	2.3.5 The Vee Model	18
	2.4 A Short History of Systems Engineering.....	19
Chapter 3	Systems Thinking Tracks	23
	3.1 Introduction.....	23
	3.2 Dynamic Thinking	25
	3.3 Feedback Thinking	27
	3.4 Specific–Generic Thinking	29
	3.5 Operational Thinking.....	30
	3.6 Scales Thinking	31
	3.7 Scientific Thinking.....	32

3.8	Decomposition–Composition Thinking.....	34
3.9	Hierarchical Thinking.....	35
3.10	Organizational Thinking.....	37
3.11	Life-Cycle Thinking.....	38
3.11.1	Product Life-Cycle Thinking.....	38
3.11.2	Resource Life-Cycle Thinking.....	40
3.11.3	Organization Life-Cycle Thinking.....	40
3.12	Safety Thinking.....	41
3.13	Risk Thinking.....	42
3.14	Summary.....	43
Chapter 4	System Design Tools.....	45
4.1	Introduction.....	45
4.2	Nine-Window Diagram.....	45
4.3	Context Diagram.....	46
4.4	Scenarios.....	48
4.5	Functional Modeling and Analysis.....	50
4.5.1	Function Trees.....	50
4.5.2	Functional Block Diagrams.....	51
4.5.3	State Transition Diagrams.....	52
4.5.4	Influence Diagrams.....	53
4.6	N ² Diagram.....	55
4.7	Architectures.....	56
4.8	System Budgets.....	58
4.9	FunKey Architecting.....	60
4.9.1	Coupling Matrix to Budgets.....	62
4.9.2	FunKey as Tracking Tool.....	62
4.10	A3 Architecture Overviews.....	63
4.11	Failure Mode and Effect Analysis.....	66
4.11.1	Introduction.....	66
4.11.2	FMEA Team.....	66
4.11.3	FMEA Form.....	67
4.11.4	FMEA Procedure.....	67
4.12	Risk Management.....	71
4.12.1	Decision Tree.....	72
4.12.2	Risk Register.....	74
4.13	Documentation and Reviewing.....	75
4.13.1	General Documentation Guidelines.....	76
4.13.2	Document Contents.....	77
4.13.2.1	Requirements Document.....	77
4.13.2.2	Design Document.....	78
4.13.2.3	Other Documents.....	79
4.13.3	Reviewing Documents.....	79
4.13.4	Open Issues and Decisions.....	81

	4.14 Modeling and Simulation	82
	4.15 Question Generator	83
Chapter 5	The Systems Engineer at Work	85
	5.1 Communication in Systems Engineering.....	87
	5.2 The Systems Engineer and the Project Manager	89
Appendix A	TRIZ	93
	A.1 Short Introduction to TRIZ.....	93
	A.1.1 Positive Priority Matrix, PM^+	94
	A.1.2 Negative Priority Matrix, PM^-	95
Appendix B	Types of Failure Modes and Effect Analysis.....	99
Appendix C	Document Template.....	101
Bibliography	105
Index	111