Contents

Preface to the Second Edition	xiii
The Role of Object Orientation	xiv
The Purpose of Case Studies	xiv
Instructor Resources	XV
Preface to the First Edition	xvii
Audience	xviii
Prerequisites	xviii
Organization and Content	xviii
Exercises	xix
Case Studies	xix
Laboratory Course	xix
Reading Graph	х
Acknowledgments	Х
Chapter 1 Software Engineering: A Preview	1
1.1 The Role of Software Engineering in System Design	2
1.2 A Shortened History of Software Engineering	3
1.3 The Role of The Software Engineer	5
1.4 The Software Life Cycle	6
1.5 The Relationship of Software Engineering to Other Areas	
of Computer Science	8
1.5.1 Programming Languages	9
1.5.2 Operating Systems	10
1.5.3 Data Bases	10
1.5.4 Artificial Intelligence	11
1.5.5 Theoretical Models	12
1.6 The Relationship of Software Engineering to Other Disciplines	12
1.6.1 Management Science	13
1.6.2 Systems Engineering	13
1.7 Concluding Remarks	13
Bibliographic Notes	14

all a subscript

	5.5.2 UML Diagrams for Specifying Behaviors	177
	5.5.3 Finite State Machines: Describing Control Flow	179
	5.5.4 Petri Nets: Specifying Asynchronous Systems	185
	5.6 Descriptive Specifications	210
	5.6.1 Entity-Relationship Diagrams	210
	5.6.2 Logic Specifications	213
	5.6.3 Algebraic Specifications	229
	5.7 Building and Using Specifications in Practice	236
	5.7.1 Requirements for Specification Notations	236
	5.7.2 Building Modular Specifications	240
	5.7.3 Specifications for the End User	257
	Concluding Remarks	258
	Further Exercises	259
	Hints and Sketchy Solutions	262
	Bibliographic Notes	266
Chapter 6	Verification	269
	6.1 Goals and Requirements of Verification	270
	6.1.1 Everything Must Be Verified	271
	6.1.2 The Results of Verification May Not Be Binary	271
	6.1.3 Verification May Be Objective or Subjective	272
	6.1.4 Even Implicit Qualities Must Be Verified	273
	6.2 Approaches to Verification	274
	6.3 Testing	274
	6.3.1 Goals for Testing	275
	6.3.2 Theoretical Foundations of Testing	277
	6.3.3 Empirical Testing Principles	280
	6.3.4 Testing in the Small	282
	6.3.5 Testing in the Large	302
	6.3.6 Separate Concerns in the Testing Activity	312
	6.3.7 Testing Concurrent and Real-Time Systems	313
	6.4 Analysis	316
	6.4.1 Informal Analysis Techniques	317
	6.4.2 Correctness Proofs	320
	6.5 Symbolic Execution	337
	6.5.1 Basic Concepts of Symbolic Execution	339
	6.5.2 Programs with Arrays	342
	6.5.3 The Use of Symbolic Execution in Testing	345
	6.6 Model Checking	347
	6.7 Putting it All Together	349
	6.8 Debugging	351
	6.9 Verifying Other Software Properties	355
	6.9.1 Verifying Performance	356

	6.9.2	Verifying Reliability	356
	6.9.3	Verifying Subjective Qualities	360
		Concluding Remarks	371
		Further Exercises	372
		Hints and Sketchy Solutions	378
		Bibliographic Notes	381
Chapter 7	The Sof	tware Production Process	385
	7.1	What is a Software Process Model?	386
	7.2	Why Are Software Process Models Important?	388
	7.3	The Main Activities of Software production	391
	7.3.1	Feasibility Study	391
	7.3.2		392
	7.3.3		399
	7.3.4	8	399
	7.3.5	<i>c</i> , <i>c</i>	400
	7.3.6		400
	7.3.7		401
	7.4	An Overview of Software Process Models	403
	7.4.1		403
	7.4.2		410
	7.4.3		413
	7.4.4	1	416
	7.4.5		417
	7.5	Dealing with Legacy Software	420
	7.6	Case Studies	421
	7.6.1	, i 8,	421
	7.6.2	, , ,	426
	7.6.3		430
	7.6.4		431
	7.7	Organizing the Process	433 434
	7.7.1	, e	434
	7.7.2		439
	7.7.3 7.8	Organizing Artifacts: Configuration Management	444
	7.8 7.9	Software Standards	451
	7.9	Concluding Remarks	451
	/.10	Further Exercises	452
		Hints and Sketchy Solutions	453
		Bibliographic Notes	454
Chapter 8	Manage	ement of Software Engineering	457
•	8.1	Management Functions	459

х	Contents

	8.2	Project Planning	460
	8.2.1	Software Productivity	462
	8.2.2	People and Productivity	469
	8.2.3	Cost Estimation	469
	8.3	Project Control	476
	8.3.1	Work Breakdown Structures	477
	8.3.2	Gantt Charts	478
	8.3.3	PERT Charts	479
	8.3.4	Dealing with Deviations from the Plan	482
	8.4	Organization	483
	8.4.1	Centralized-Control Team Organization	486
	8.4.2	Decentralized-Control Team Organization	487
	8.4.3	Mixed-Control Team Organization	488
	8.4.4	An Assessment of Team Organizations	489
	8.5	Risk Management	490
	8.5.1	Typical Management Risks in Software Engineering	491
	8.6	Capability Maturity Model	492
	8.7	Concluding Remarks	495
		Further Exercises	497
		Hints and Sketchy Solutions	498
		Bibliographic Notes	499
Chapter 9	Softwa	501	
	9.1	Historical Evolution of Tools and Environments	502
	9.2	Dimensions for Comparing SoftwareTools	503
	9.3	Representative Tools	507
	9.3.1	Editors	507
	9.3.2	Linkers	508
	9.3.3	Interpreters	508
	9.3.4	Code Generators	509
	9.3.5	5 Debuggers	510
	9.3.6	5 Tools Used in Software Testing	511
	9.3.7	7 Static Analyzers	512
	9.3.8	B Graphical User Interface Tools	514
	9.3.9	9 Configuration Management Tools	516
	9.3.1	10 Tracking tools	520
	9.3.1	11 Reverse and reengineering tools	521
	9.3.2	12 Process support tools	522
	9.3.1	13 Management Tools	522
	9.4	Tool Integration	523
	9.5	Forces Influencing the Evolution of Tools	524
	9.6	Concluding Remarks	525
		Further Exercises	525
		Hints and Sketchy Solutions	526 526

536

Chapter 10	Epilo	529	
	10.1	The Future	529
	10.2	Ethics and Social Responsibility	532
	10.3	Software Engineering Code of Ethics	533
	10.4	Concluding Remarks	534
		Bibliographic notes	534

Appendix

Case Studies

Cas	e Study	A: Automating a Law Office	536
	A.1	Economic and Financial Planning	538
	A.2	Technical Planning and Management	538
	A.3	Project Monitoring	540
	A.4	Initial Delivery	540
	A.5	Partial Recovery	541
Cas	e Study	B: Building a Family of Compliers	541
	B .1	Initial Product Planning	541
	B.2	Economic and Financial Planning	542
	B .3	Technical Planning and Management	542
	B.4	Early Development Phases	543
	B.5	Project Monitoring	543
	B .6	Project Reexamination, Revival, And Goal Setting	544
	B .7	Assignment of Responsibility	545
	B.8	Steady Progress and Release of the Product	546
	B .9	Product Distribution	546
	B .10	Remarks	546
Cas	e Study	C: Incremental Delivery	549
Cas	e Study	D. Applying Formal Methods in Industry	550
	D.1	Education and Training	551
	D.2	Requirements Specification	552
	D.3	Requirements Validation and Verification Planning	553
	D.4	Design, Implementation, and Verification	555
	D.5	Overall Evaluation and Assessment	555
	D.6	The Impact of the Project on Company's Strategy	557
	Concl	luding Remarks	558
	Biblic	ographic Notes	559
Bibliograph	у		560
Index			589