

Object-Oriented Systems Analysis and Design

Noushin Ashrafi

*Professor of Information System
University of Massachusetts–Boston*

Hessam Ashrafi

Software Architect

CONTENTS

Preface	xii
Acknowledgments	xviii
About the Authors	xix

PART I: THE FOUNDATIONS 1

CHAPTER 1 Information Systems 1

1. Overview	1
<i>Chapter Topics</i>	1
<i>Introduction</i>	1
2. Introducing Information Systems	3
<i>Information</i>	3
<i>System</i>	6
<i>The Information System</i>	9
<i>The Information Technology</i>	10
<i>Applications and Systems</i>	13
3. The Information System as Product	14
<i>Business and Information Systems</i>	15
<i>The Business of Information Systems</i>	15
<i>Infrastructural Information Systems</i>	16
<i>The Enterprise of Software Development</i>	17

CHAPTER 2 The Concept of Object Orientation 30

1. Overview	30
<i>Chapter Topics</i>	30
<i>Introduction</i>	30
2. Introducing Objects	31
<i>Real Objects</i>	31
<i>Virtual Objects</i>	36
3. The Origins of Object-Oriented Technology	44
<i>Object-Oriented Languages</i>	45
4. Object-Oriented Modeling	46
5. The Unified Modeling Language (UML)	47

CHAPTER 3 Methodology 54

1. Overview	54
<i>Chapter Topics</i>	54
<i>Introduction</i>	54
2. Introducing Methodology	55
<i>Defining Methodology</i>	55
<i>Generalization, Abstraction & Innovation</i>	56
<i>Challenges of Methodology</i>	57

<i>Methodologies in Parallel</i>	59
<i>Methodology & Technology</i>	60
<i>Variations on a Theme</i>	60
<i>Organization as Methodology</i>	61
<i>Methodology as Product</i>	61
<i>Benefits & Risks</i>	62
3. Concepts in Software Development Methodologies	64
<i>What Do Methodologies Address?</i>	64
<i>The Ad Hoc Approach</i>	65
<i>System Development Life Cycle (SDLC)</i>	65
<i>Agile Methodologies</i>	72
<i>The Capability Maturity Model (CMM)</i>	75
<i>Modeling</i>	77
<i>Object-Oriented Development</i>	80
4. Project Management Concepts	81
<i>Defining Project</i>	82
<i>Project Management & Software Development</i>	92

PART II: ANALYSIS 101

CHAPTER 4 Gathering Requirements 101

1. Overview	101
<i>Chapter Topics</i>	101
<i>Introduction</i>	101
2. Defining Requirements	103
3. Requirements Discovery	103
4. Classifying Requirements	105
<i>Functional Requirements</i>	105
<i>Nonfunctional Requirements</i>	106
5. Techniques for Eliciting Requirements	109
<i>Interviews</i>	109
<i>Questionnaires</i>	117
<i>Elicitation Workshops</i>	120
<i>Field Trips & Observation</i>	121
<i>Modeling</i>	123
6. Sources & Authorities	125
<i>Sponsors</i>	125
<i>Domain Experts</i>	125
<i>Stakeholders</i>	126
<i>Users</i>	127
<i>Reverse Engineering</i>	127
7. Managing Requirements	129
8. Case History: Walden Medical Center	130
<i>The Rise</i>	131
<i>The Decline</i>	131
<i>The Revival</i>	132
<i>Inception of the Project</i>	132
<i>Initial Requirements</i>	135
9. Deliverables	135

CHAPTER 5 Domain Analysis 145

1. Overview 145
 - Chapter Topics* 145
 - Introduction* 146
2. Problems, Solutions, and Requirements 148
 - Problems vs. Solutions* 148
 - Problem Space vs. Solution Space* 150
 - Requirements vs. Product Specifications* 152
3. Domain Definition 154
 - The Meaning of Domain* 154
 - The Domain Scope* 155
 - Domains and Subsystems* 156
 - Walden's Domain Definitions* 157
4. Domain Analysis 159
 - Finding Domain Concepts* 160
 - Domain Dictionary* 164
 - Beyond Application Boundaries* 168
5. Business Rules 169
 - Definition and Significance* 170
 - Classification* 170
 - Managing Business Rules* 173
6. Deliverables 176

CHAPTER 6 Behavioral Modeling I: Use Cases: The Basics 181

1. Overview 181
 - Chapter Topics* 181
 - Introduction* 182
2. Introducing Use Cases 183
 - What Use Case Modeling Is* 183
 - What Use Case Modeling Is Not* 184
 - Components of a Use Case* 185
 - Use Cases in the Modeling Spectrum* 194
3. Develop Initial Use Cases 195
 - From Domain Analysis to Use Cases* 195
 - Identify Prominent Actors* 196
 - Identify Major Use Cases* 199
 - Develop Context Diagram* 201
4. Deliverables 202

CHAPTER 7 Behavioral Modeling II: Developing Use Cases 206

1. Overview 206
 - Chapter Topics* 207
 - Introduction* 207
2. Develop Base Use Cases 208
 - What a "Base" Use Case Is* 208
 - The Template* 209
 - Template Fields* 209
3. Actor Generalization 223
4. Dependencies: Include and Extend 225
 - Extend Relationship* 225

<i>Include Relationship</i>	227
<i>Use Case Diagram for Dependencies</i>	228
5. Use Case Generalization	229
<i>Make Appointment: New Requirement</i>	229
<i>One Goal, Two Use Cases</i>	230
<i>The Parent</i>	231
<i>The Children</i>	231
<i>Replacing Alternates</i>	232
6. Use Case Diagram	232
7. Separating and Joining Use Cases	233
<i>Delineating Use Cases</i>	233
<i>Dividing Use Cases</i>	235
8. Activity Diagram	238
9. Uses of Use Cases	238
10. Use Case Supplements	241
11. Deliverables	243

CHAPTER 8 Structural Modeling 248

1. Overview	248
<i>Chapter Topics</i>	248
<i>Introduction</i>	249
2. Introducing Structural Modeling	249
3. Classes & Structural Modeling	251
<i>Classes as Object Templates</i>	251
<i>Classes as Building Blocks</i>	252
<i>Objects as Black Boxes</i>	253
<i>Interface</i>	254
<i>Structuring the Interface</i>	256
<i>Composite & Collection Objects</i>	258
4. Finding Classes	259
<i>From Use Cases to Classes</i>	259
<i>Elaborating Classes</i>	267
5. Relationships	276
<i>Association</i>	276
<i>Class Diagram</i>	277
<i>Multiplicity</i>	279
<i>Aggregation & Composition</i>	281
<i>Constraints</i>	282
<i>Generalization & Specialization</i>	283
6. Deliverables	285

CHAPTER 9 Dynamic Modeling 293

1. Overview	293
<i>Chapter Topics</i>	293
<i>Introduction</i>	294
2. Introducing Dynamic Modeling	295
3. Object Interaction	297
<i>Messages</i>	297
<i>Methods</i>	303

<i>Accessor Operations</i>	304
<i>Events</i>	305
4. Dynamic Diagrams	310
<i>Sequence Diagram</i>	310
<i>Collaboration Diagram</i>	319
<i>Statechart Diagram</i>	322
<i>Activity Diagram</i>	326
5. Deliverables	327

PART III: DESIGN 335

CHAPTER 10 The Design Challenge 335

1. Overview	335
<i>Chapter Topics</i>	335
<i>Introduction</i>	336
2. Introducing Design	338
<i>Defining Design</i>	338
<i>From Analysis to Design</i>	340
<i>Concrete Modeling: Logical & Physical</i>	342
<i>The Design Paradigms</i>	343
<i>The Significance of Domain Analysis</i>	344
3. Design Concepts	345
<i>Design Objects</i>	347
<i>UML Extension Mechanisms</i>	349
4. Packaging	358

CHAPTER 11 Application Design I: Flow & Control 368

1. Overview	368
<i>Chapter Topics</i>	368
<i>Introduction</i>	369
2. Introducing Flow & Control	370
3. Plotting the Flow	371
<i>Moving to Design: Magnifying the Use Case Flow</i>	371
<i>The Flow Object</i>	374
<i>The Life Cycle Object</i>	375
<i>The Dataset</i>	378
<i>The Application Control</i>	379
4. Defining Concrete Classes	383
<i>Methods Revisited</i>	384
<i>Deriving Methods from Messages</i>	385
<i>Exposing Attributes</i>	387
<i>Construction & Destruction of Objects</i>	389
<i>Overloading Methods</i>	389
5. The Web Control Model	390
6. Deliverables	393

CHAPTER 12 Application Design II: The User Interface 399

1. Overview	399
<i>Chapter Topics</i>	399
<i>Introduction</i>	400

2. Introducing the User Interface	401
<i>The Responsibilities of the User Interface</i>	402
<i>The Evolution of the User Interface</i>	403
<i>User Interface Objects</i>	403
3. The Language of the User Interface	404
<i>The Metaphors</i>	404
<i>The Roles</i>	405
<i>The Grammar of the User Interface</i>	417
4. Shaping Messages into the User Interface	419
<i>Mapping Parameters & Attributes</i>	420
<i>Constraints in UI Design</i>	424
5. Modeling the User Interface	425
<i>Class Diagrams</i>	426
<i>Navigation</i>	429
<i>Storyboarding</i>	429
<i>Simulation & Prototyping</i>	432
6. Deliverables	435

CHAPTER 13 Application Design III: Database & Persistence 441

1. Overview	441
<i>Chapter Topics</i>	442
<i>Introduction</i>	442
2. Data & Data Management	443
<i>Data</i>	443
<i>Data Management</i>	445
<i>The Database Management System (DBMS)</i>	448
3. The Relational Model	453
<i>Tables</i>	454
<i>The Foreign Key</i>	456
<i>Data Integrity</i>	457
<i>SQL</i>	461
<i>Data Normalization</i>	467
<i>Intersection Tables</i>	473
<i>Lookup Tables</i>	476
<i>Modeling the Relational Database</i>	477
4. Designing Persistence	480
<i>Mapping to Relational Databases</i>	480
<i>The Persistence Layer</i>	485
5. Deliverables	489

CHAPTER 14 Patterns 496

1. Overview	496
<i>Chapter Topics</i>	496
<i>Introduction</i>	497
2. Introducing Patterns	497
<i>The Background</i>	498
<i>The Pattern Language</i>	500
<i>The Risks</i>	501
3. Design Patterns	502
<i>Factory Method</i>	503
<i>The Object Adapter</i>	505

4. Analysis Patterns	506
<i>Measurement & Historical Mapping</i>	507
5. Modeling Patterns	508
<i>Dynamic Object Types</i>	509
6. Anti-Patterns	510
<i>Functional Decomposition</i>	510
7. Deliverables	512

CHAPTER 15 Components & Reuse 516

1. Overview	516
<i>Chapter Topics</i>	516
<i>Introduction</i>	517
2. Areas of Reuse	517
3. Inheritance Reuse	519
<i>Implementation Inheritance</i>	519
<i>Interface Inheritance</i>	522
<i>Emulating Inheritance by Composition</i>	525
4. Components	527
<i>Defining Components</i>	528
<i>Modeling Components</i>	531
<i>Component-Based Development (CBD)</i>	534
5. Deliverables	537

CHAPTER 16 Architecture 542

1. Overview	542
<i>Chapter Topics</i>	542
<i>Introduction</i>	543
2. Architectural Concepts	545
<i>Defining Architecture</i>	545
3. The Architecture of the Information System	555
<i>Technology</i>	556
<i>Components & Applications</i>	558
<i>Data Management</i>	563
<i>Modeling & Conceptualization</i>	564
<i>Workflow</i>	565
4. Architectural Patterns	566
<i>The Layering Pattern</i>	567
5. Deliverables	572

CHAPTER 17 Implementation 581

1. Overview	581
<i>Chapter Topics</i>	581
<i>Introduction</i>	581
2. Coding	582
<i>The Choice of the Language</i>	584
<i>Programming Tools</i>	585
<i>Coding Standards</i>	588
<i>Code Review</i>	589

3.	Testing	590
	<i>Levels of Testing</i>	591
	<i>Testing & Object Orientation</i>	592
4.	Deployment	593
	<i>The Deployment Diagram</i>	594
	<i>User Training</i>	596
	<i>Change & Maintenance</i>	599
5.	Deliverables	600
	References	606
	Index	611