

Contents

Foreword by Peter Freeman xv
Foreword by Bran Selic xvii
Preface xix

PART I UML NOTATION, DESIGN CONCEPTS, TECHNOLOGY, LIFE CYCLES AND METHODS	1
1 Introduction	3
1.1 Object-Oriented Methods and the Unified Modeling Language	4
1.2 Method and Notation	5
1.3 Concurrent Applications	6
1.4 Real-Time Systems and Applications	8
1.5 Distributed Systems and Applications	10
1.6 Summary	11
2 Overview of UML Notation.....	13
2.1 UML Diagrams.....	13
2.2 Use Case Diagrams	14
2.3 UML Notation for Classes and Objects	14
2.4 Class Diagrams	15
2.5 Interaction Diagrams	17
2.6 Statechart Diagrams	19
2.7 Packages	20
2.8 Concurrent Collaboration Diagrams.....	21

2.9	Deployment Diagrams	23
2.10	UML Extension Mechanisms	24
2.11	The UML as a Standard.....	25
2.12	Summary	26
3	Software Design and Architecture Concepts.....	27
3.1	Object-Oriented Concepts.....	27
3.2	Information Hiding	30
3.3	Inheritance.....	36
3.4	Active and Passive Objects.....	37
3.5	Concurrent Processing	38
3.6	Cooperation between Concurrent Tasks.....	40
3.7	Information Hiding Applied to Access Synchronization..	49
3.8	Monitors	51
3.9	Design Patterns.....	53
3.10	Software Architecture and Component-Based Systems...	55
3.11	Summary	56
4	Concurrent and Distributed System Technology	57
4.1	Environments for Concurrent Processing	57
4.2	Runtime Support for Multiprogramming and Multiprocessing Environments	60
4.3	Task Scheduling	63
4.4	Operating System Input/Output Considerations.....	65
4.5	Client/Server and Distributed System Technology	68
4.6	World Wide Web Technology.....	73
4.7	Distributed Operating System Services	75
4.8	Middleware.....	78
4.9	Common Object Request Broker Architecture (CORBA)..	81
4.10	Other Component Technologies	85
4.11	Transaction Processing Systems.....	86
4.12	Summary	88
5	Software Life Cycles and Methods	91
5.1	Software Life Cycle Approaches	91
5.2	Design Verification and Validation	98
5.3	Software Testing.....	99
5.4	Evolution of Software Design Methods	101

5.5	Evolution of Object-Oriented Analysis and Design Methods	103
5.6	Survey of Concurrent and Real-Time Design Methods ...	105
5.7	Summary.....	106
PART II	COMET: CONCURRENT OBJECT MODELING AND ARCHITECTURAL DESIGN WITH UML	107
6	Overview of COMET	109
6.1	COMET Object-Oriented Software Life Cycle.....	109
6.2	Comparison of the COMET Life Cycle with Other Software Processes.....	112
6.3	Requirements, Analysis, and Design Models	113
6.4	The COMET in a Nutshell	115
6.5	Summary.....	118
7	Use Case Modeling	119
7.1	Use Cases	119
7.2	Actors.....	120
7.3	Actors, Roles, and Users.....	123
7.4	Identifying Use Cases	123
7.5	Documenting Use Cases in the Use Case Model	124
7.6	Examples of Use Cases	125
7.7	Use Case Relationships.....	130
7.8	Use Case Packages.....	134
7.9	Summary.....	135
8	Static Modeling	137
8.1	Associations between Classes	137
8.2	Composition and Aggregation Hierarchies.....	145
8.3	Generalization/Specialization Hierarchy	147
8.4	Constraints	149
8.5	Static Modeling and the UML	149
8.6	Static Modeling of the System Context.....	152
8.7	Static Modeling of Entity Classes	155
8.8	Summary.....	157
9	Object and Class Structuring.....	159
9.1	Object Structuring Criteria.....	160
9.2	Categorization of Application Classes	160

9.3	Object Structuring Categories	162
9.4	External Classes and Interface Classes	163
9.5	Interface Objects	164
9.6	Entity Objects.....	170
9.7	Control Objects	172
9.8	Application Logic Objects	175
9.9	Subsystems.....	177
9.10	Summary	179
10	Finite State Machines and Statecharts	181
10.1	Finite State Machines	182
10.2	Events and States.....	182
10.3	Finite State Machines and Objects	183
10.4	Examples of Statecharts	183
10.5	Events and Conditions.....	187
10.6	Actions	190
10.7	Modeling Different Aspects of the System	196
10.8	Hierarchical Statecharts	198
10.9	Concurrent Statecharts.....	201
10.10	Guidelines for Developing Statecharts	203
10.11	Developing Statecharts from Use Cases	204
10.12	Example of Developing a Statechart from a Use Case..	205
10.13	Summary	212
11	Dynamic Modeling.....	215
11.1	Object Interaction Modeling	216
11.2	Message Labels on Interaction Diagrams	220
11.3	Dynamic Analysis.....	224
11.4	Non-State-Dependent Dynamic Analysis	224
11.5	Example of Non-State-Dependent Dynamic Analysis ..	226
11.6	State-Dependent Dynamic Analysis.....	227
11.7	Example of State-Dependent Dynamic Analysis: Banking System.....	230
11.8	Example of State-Dependent Dynamic Analysis: Cruise Control System	240
11.9	Summary	250

12 Software Architecture Design.....	253
12.1 Software Architectural Styles.....	253
12.2 System Decomposition Issues	257
12.3 Guidelines for Determining Subsystems	259
12.4 Consolidated Collaboration Diagrams.....	260
12.5 Subsystem Software Architecture	261
12.6 Separation of Concerns in Subsystem Design.....	261
12.7 Subsystem Structuring Criteria	265
12.8 Examples of Subsystem Decomposition.....	269
12.9 Static Modeling at the Design Level	270
12.10 Summary.....	274
13 Architectural Design of Distributed Applications.....	275
13.1 Configurable Architectures and Software Components	276
13.2 Steps in Designing Distributed Applications	276
13.3 System Decomposition	277
13.4 Designing Subsystem Interfaces	283
13.5 Transaction Management	292
13.6 Design of Server Subsystems	295
13.7 Distribution of Data.....	300
13.8 System Configuration	301
13.9 Summary.....	303
14 Task Structuring.....	305
14.1 Concurrent Task Structuring Issues	306
14.2 Task Structuring Categories.....	307
14.3 I/O Task Structuring Criteria.....	308
14.4 Internal Task Structuring Criteria	317
14.5 Task Priority Criteria.....	324
14.6 Task Clustering Criteria	325
14.7 Design Restructuring by Using Task Inversion.....	337
14.8 Developing the Task Architecture	341
14.9 Task Communication and Synchronization.....	345
14.10 Task Behavior Specifications	354
14.11 Summary.....	359

15 Class Design.....	361
15.1 Designing Information Hiding Classes	361
15.2 Designing Class Operations	362
15.3 Data Abstraction Classes	367
15.4 Device Interface Classes.....	369
15.5 State-Dependent Classes	375
15.6 Algorithm Hiding Classes.....	378
15.7 User Interface Classes.....	378
15.8 Business Logic Classes	381
15.9 Database Wrapper Classes.....	383
15.10 Software Decision Classes	384
15.11 Inheritance in Design	386
15.12 Examples of Inheritance.....	387
15.13 Class Interface Specifications	393
15.14 Summary	396
16 Detailed Software Design.....	397
16.1 Design of Composite Tasks	397
16.2 Synchronization of Access to Classes.....	405
16.3 Designing Connectors for Inter-Task Communication..	414
16.4 Task Event Sequencing Logic	420
16.5 Summary	421
17 Performance Analysis of Concurrent Real-Time Software Designs	423
17.1 Real-Time Scheduling Theory	423
17.2 Advanced Real-Time Scheduling Theory	431
17.3 Performance Analysis Using Event Sequence Analysis	436
17.4 Performance Analysis Using Real-Time Scheduling Theory and Event Sequence Analysis	437
17.5 Example of Performance Analysis Using Event Sequence Analysis	438
17.6 Example of Performance Analysis Using Real-Time Scheduling Theory	442
17.7 Example of Performance Analysis Using Real-Time Scheduling Theory and Event Sequence Analysis	444
17.8 Design Restructuring	452
17.9 Estimation and Measurement of Performance Parameters.....	453
17.10 Summary	454

PART III CASE STUDIES IN CONCURRENT, DISTRIBUTED, AND REAL-TIME APPLICATION DESIGN	457
18 Elevator Control System Case Study	459
18.1 Problem Description	459
18.2 Use Case Model	460
18.3 Static Model of the Problem Domain	465
18.4 Object Structuring	466
18.5 Dynamic Model	467
18.6 Statechart Model	476
18.7 Consolidation of Collaboration Diagrams	480
18.8 Subsystem Structuring	482
18.9 Structuring System into Tasks	487
18.10 Design of Distributed Elevator Control System	495
18.11 Design of Information Hiding Classes	503
18.12 Developing Detailed Software Design	508
18.13 Target System Configuration	511
18.14 Performance Analysis of Non-Distributed Elevator Control System	512
18.15 Performance Analysis of Distributed Elevator Control System	520
19 Banking System Case Study	531
19.1 Problem Description	531
19.2 Use Case Model	532
19.3 Static Modeling	536
19.4 Object Structuring	541
19.5 Dynamic Modeling	547
19.6 ATM Statechart	560
19.7 Design of Banking System	565
19.8 Consolidating the Collaboration Model	565
19.9 Structuring the System into Subsystems	568
19.10 Design of ATM Client Subsystem	571
19.11 Design of Bank Server Subsystem	580
19.12 Configuration of Banking System	587
19.13 Alternative Design Considerations	587
19.14 Task Behavior Specifications	587
20 Cruise Control and Monitoring System Case Study	595
20.1 Problem Description	595

20.2	Use Case Model	597
20.3	Use Case Descriptions	600
20.4	Problem Domain Static Modeling	605
20.5	Dynamic Modeling	608
20.6	Subsystem Structuring	623
20.7	Refined Static Modeling	632
20.8	Structuring the System into Tasks	635
20.9	Information Hiding Class Design	657
20.10	Developing Detailed Software Design	665
20.11	Software Architecture of Distributed Automobile System	671
21	Distributed Factory Automation System Case Study	673
21.1	Problem Description	673
21.2	Use Case Model	675
21.3	Conceptual Static Model of the Problem Domain	678
21.4	Object Structuring	680
21.5	Dynamic Model	682
21.6	Subsystem Structuring	698
21.7	Distributed Software Architecture	702
21.8	System Configuration	710
22	Electronic Commerce System Case Study	713
22.1	Electronic Commerce Problem	713
22.2	Use Case Model	714
22.3	Agent Support for Electronic Commerce System	715
22.4	Object Broker Support for Electronic Commerce System	717
22.5	Static Modeling of the Problem Domain	718
22.6	Collaboration Model	719
22.7	Distributed Software Architecture	728
Appendix A	Conventions and Alternative Notations	737
A.1	Conventions Used in This Book	737
A.2	Alternative Notation for Stereotypes	739
A.3	Alternative Notation for Active Objects	740
	Glossary	743
	Bibliography	757
	Index	767