Lecture Notes in
Computer Science 1743

Ana Moreira Serge Demeyer (Eds.)

# Object-Oriented Technology

## ECOOP'99 Workshop Reader

ECOOP'99 Workshops, Panels, and Posters
Lisbon, Portugal, June 1999
Proceedings

13th European Conference on
Object-Oriented Programming
Lisbon, Portugal
14-18 June 1999
ECOOP
Lisboa 99

Springer

2-005-566-1

2-005-566-1

Ana Moreira Serge Demeyer (Eds.)

# Object-Oriented Technology

## ECOOP'99 Workshop Reader

ECOOP'99 Workshops, Panels, and Posters
Lisbon, Portugal, June 14-18, 1999
Proceedings

Springer

# Table of Contents

**Object Interoperability** .......... 1
*Antonio Vallecillo, Juan Hernández, and José M. Troya*

Protocol-Safe Workflow Support for Santa Claus (Rick van Rein) .......... 4

Extending IDLs with $\pi$-calculus for Protocol Compatibility (Carlos Canal, Lidia Fuentes, and Antonio Vallecillo) .......... 5

Semantic and Usage Packaging for Software Components (Jun Han) .... 7

Semantic Trading: Tackling Interoperability Problems During System Integration (Sortirios Terzis and Pady Nixon) .......... 9

Reasoning about Object Clients and Distributed Object Interaction (Anna Mikhajlova) .......... 10

Automatic Selection of Problem Solving Libraries Based on Competence Matching (Mauro Gaspari, Enrico Motta, and Dieter Fensel) .......... 10

Behavioural Mapping for Service Substitutability (T. Senivongse) ..... 12

Conceptual Design and Development of Applications Based on Object Interoperability (Jaime Gómez and Oscar Pastor) .......... 13

Improving the Interoperability in Multi-agent Systems (Juan M. Corchado and Pedro Cuesta) .......... 14

**Object-Orientation and Operating Systems** .......... 22
*Lutz Wohlrab, Francisco Ballesteros, Frank Schubert, Henning Schmidt, and Ashish Singhai*

2K: An OS for the New Millennium (Roy H. Campbell) .......... 24

Automatic Configuration in the 2K Operating System (Fabio Kon, Dulineia Carvalho, and Roy H. Campbell) .......... 25

Adaptation Manager: Continued Story (Lutz Wohlrab) .......... 25

An Explicit Binding Model for Runtime Extensible Operating Systems (Michael Clarke and Geoff Coulson) .......... 25

GoodeWatch: Supervision of CORBA Applications (Christophe Gransart, Phillippe Merle, and Jean-Marc Geib) .... 26

On the Development of Object-Oriented Operating Systems for Deeply Embedded Systems – The PURE Project (Danilo Beuche, Abdelaziz Guerrouat, Holger Papajewski, Wolfgang Schröder-Preikschat, Olaf Spinczyk, and Ute Spinczyk) . 26

Scalable Adaptation Based on Decomposition – A Modest Subset of Family-Oriented Adaptation Schemes (Reinhard Meyer and Henning Schmidt) .......... 27

EPOS: An Object-Oriented Operating System (Antônio Augusto Fröhlich and Wolfgang Schröder-Preikschat) ... 27

An Object-Oriented, Dynamically Adaptable, Virtual File System for CHEOPS (Frank Schubert and Kevin Brem) .......... 27

Object-Orientation in Off++ – A Distributed Adaptable Microkernel (Francisco Ballesteros, Christopher Hess, Fabio Kon, Sergio Arevalo, and Roy H. Campbell) .......... 27
Eliminating Garbage Collection by Using Virtual Memory Techniques to Implement Complete Object Persistence (Darío Álvarez Gutiérrez, María Ángeles Díz Fondón, Fernando Álvarez García, and Lourdes Tajes Martínez) .......... 28
Object Model with Exchangeable Invocation Semantics (Markus Hof) . 28

**UML Semantics FAQ** .......... 33
*Stuart Kent, Andy Evans, and Bernhard Rumpe (Editors on Behalf of the pUML Group)*
Introduction .......... 33
Q1. What Does the Term *Semantics* Mean in the Context of UML? (Bernhard Rumpe, Stuart Kent, Andy Evans, and Robert France) 34
Q2. Is a Precise Semantics Desirable? For What Purpose? (Stuart Kent, Bernhard Rumpe, Andy Evans, and Robert France) 37
Q3. What Is the Current State of UML Semantics? What Are the Reference Documents? (Martin Gogolla, Mark Richters, and Oliver Radfelder) .......... 40
Q4. Should UML Have a Single Semantics? Sould UML Have a Single *Core* Semantics? (John Howse, Shusaku Iida, Richard Mitchell, and Bernhard Rumpe) .......... 41
Q5. Is It Possible to Express a Semantics of UML in UML? (The Meta-modelling Approach) (Martin Gogolla, Stuart Kent, Tom Mens, Mark Richters, and Oliver Radfelder) .......... 45
Q6. Is It Feasable to Construct a Semantics for All of UML? What Are the Outstanding Issues? (Roel Wieringa, Egidio Astesiano, Gianna Reggio, Alain Le Guennec, Heinrich Hussman, Klaas van den Berg, and Pim van den Broeck) .......... 49

**Object-Oriented Architectural Evolution** .......... 57
*Isabelle Borne, Serge Demeyer, and Galal Hassan Galal*
Software Architecture: How Are the Boundaries Defined? (Jean-Pierre Kuilboer and Noushin Ashrafi) .......... 65
Interacting Components — A Conceptual Architecture Model (Palle Nowack) .......... 66
Searching Basic Notions for Software Architecture Design (Jorge L. Ortega-Arjona and Graham Roberts) .......... 67
A Note on Scenarios in Software Architecting (Galal Hassan Galal) .... 68
Towards Systematically Designing Evolvable Software Architectures (Lodewijk Bergmans) .......... 69
Dealing with Evolution in Family Architecture (Pierre America and William van der Sterren) .......... 70
Evolution of Layered Object-Oriented Models (Michel Dao) .......... 71
Architectural Evolution: A Multi-level Perspective (Huw Evans) ..... 71

Evolution Characteristics of an Industrial Application Framework
(Michael Mattsson) ... 72
Environment for Software Assessment
(Claudio Riva, Michael Przybilski, and Kai Koskimies) ... 74
Using Recovered Views to Track Architectural Evolution
(Tamar Richner) ... 74
Managing Unanticipated Evolution of Software Architectures
(Kim Mens, Tom Mens, Bart Wouters, and Roel Wuyts) ... 75
Architectural Evolution Support Using Architectural Contracts
(Bart Wydaeghe and Bart Michiels) ... 76
Pattern-Based Software Evolution
(Takashi Kobayashi and Saeki Motoshi) ... 77
An Environment for Building and Maintaining Class Hierarchies
(Nathalie Chevalier, Michel Dao, Christophe Dony, Marianne Huchard, Hervé Leblanc, and Thérèse Libourel) ... 77

**Multi-user Object-Oriented Environments** ... 80
*Ivan Tomek, Alicia Diaz, Ronald Melster, António Rito Silva, Miguel Antunes, Vinny Cahill, Zièd Choukair, Alexandro Fernandez, Mads Haahr, Eric Jul, Atsushi Ohnishi, Luís Rodrigues, Erich R. Schmidt, Cristian Ţăpuş, Waldemar Wieczerzycki, and Daniel M. Zimmerman*
MUM - A Multi-universe MOO (Ivan Tomek) ... 83
Collaborative Requirements Definition with VRDL (Atsushi Ohnishi) .. 84
Interfacing Real and Virtual Environments
(Mads Haahr, Vinny Cahill, and Eric Jul) ... 84
DVECOM: An Auto-adaptive Model for Collaboration within Distributed Virtual Reality Applications (Zièd Choukair) ... 86
From DASCo to MOOSCo: MOO with Separation of Concerns
(António Rito Silva and Miguel Antunes) ... 87
Mining a Pattern Language for MOO Design
(Alexandro Fernandez, Alicia Diaz, and Ronald Melster) ... 89
Scalability Issues in MOOs: The Role of Object Migration and Replication (Luís Rodrigues) ... 90
Applying the Distributed Programming Paradigm to Improve Scalability in Multi-user Environments
(Erich R. Schmidt, Cristian Ţăpuş, and Daniel M. Zimmerman) .. 91
Agora - The Multi-user Environment for Co-authoring Documents
(Waldemar Wieczerzycki) ... 92

**Formal Techniques for Java Programs** ... 97
*Bart Jacobs, Gary T. Leavens, Peter Müller, and Arnd Poetzsch-Heffter*
How to Formally Specify the Java Bytecode Semantics Using the B Method (Ludovic Casset and Jean Louis Lanet) ... 104
Towards a Modular Denotational Semantics of Java (Pietro Cenciarelli) 105
Thread and Main Memory Semantics
(Vishnu Kotrajaras and Susan Eisenbach) ... 106

A Logic of Recursive Objects (Bernhard Reus) . . . . . . . . . . . . . . . . . . . . . . 107
A Formal Approach to the Specification of Java Components (S. Cimato and P. Ciancarini) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 107
Formal Refinement and Proof of a Small Java Program (Tony Clark) . . 108
Software Development with Object-Z, CSP, and Java: A Pragmatic Link from Formal Specifications to Programs (Clemens Fischer) . . 108
A Case Study in Class Library Verification: Java's Vector Class (Marieke Huisman, Bart Jacobs, and Joachim van den Berg) . . . . . 109
Checking Java Programs via Guarded Commands (K. Rustan M. Leino, James B. Saxe, and Raymie Stata) . . . . . . . . 110
Exception Analysis for Java (Kwangkeun Yi and Byeong-Mo Chang) . . 111

**9th Workshop for PhD Students in Object Oriented Systems** . . . . 116
*Awais Rashid, David Parsons, and Alexandru Telea*

**Aliasing in Object Oriented Systems** . . . . . . . . . . . . . . . . . . . . . . . . . . . 136
*James Noble, Jan Vitek, Doug Lea, and Paulo Sergio Almeida*
Using Aliasing Information to Predict Real-Time Garbage Collection (Patrik Persson) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 137
Partial Redundancy Elimination for Access Path Expressions (Antony Hosking, Nathaniel Nystrom, David Whitlock, Quintin Cutts, and Amer Diwan) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 138
MayEqual: A New Alias Question (John Boyland and Aaron Greenhouse) . . . . . . . . . . . . . . . . . . . . . . . . . 141
PAOLA — Program Analysis of Object-Oriented Languages (Wolfram Amme, Markus Schordan, Laszlo Böszörmenyi, and Wilhelm Rossak) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 143
Flexible Aliasing with Protection (Günter Kniesel and Dirk Theisen) . 146
Alias Killing: Unique Variables without Destructive Reads (John Boyland) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 148
Overcoming Representation Exposure (David Clarke, James Noble, and John Potter) . . . . . . . . . . . . . . . . . . 149
Implementing "Object Ownership to Order" (Boris Bokowski) . . . . . . . 151
Towards Safer Aliasing with the Eiffel Language (Olivier Zendra and Dominique Colnet) . . . . . . . . . . . . . . . . . . . . . . . . . . . 153
Alias Control Is Crucial for Modular Verification of Object-Oriented Programs (Peter Müller and Arnd Poetzsch-Heffter) . . . . . . . . . . 154
Intercontinental Workshop on Aliasing in Object-Oriented Systems (Phillip M. Yelland) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 156
The Objects of Aliasing (James Noble) . . . . . . . . . . . . . . . . . . . . . . . . . . . 157

**Experiences in Object-Oriented Re-engineering** . . . . . . . . . . . . . . . . . 164
*Stéphane Ducasse and Oliver Ciupke*
Metrics-Based Problem Detection in Object-Oriented Legacy Systems Using Audit-Reengineer (Anne-Marie Sassen and Radu Marinescu) . . . . . . . . . . . . . . . . . . . . . 164

Detecting Design Defects in Object-Oriented Software (Marcelo Machado Feres) .... 166
A Guideline to Detect Reusable Components (Lucia Torres Gastal) .... 166
Understanding Object Oriented Software Systems without Source Code Inspection (Gerd Köhler, Heinrich Rust, and Frank Simon) .... 167
Reverse Engineering Based on Metrics and Program Visualization (Michele Lanza, Stéphane Ducasse, and Serge Demeyer) .... 168
Analysing Software Systems by Using Combinations of Metrics (Markus Bauer) .... 170
Simplification of Class Diagrams Using Graph Compression Techniques (Ferenc Dósa Rácz and Kai Koskimies) .... 171
Minimalist Documentation of Frameworks (Kasper Østerbye) .... 172
Formalization of UML Using Algebraic Specifications (Rachel Pires Vieira de Vasconcelos) .... 174
Dynamic Reverse Engineering of Java Software (Tarja Systä) .... 174
Tool-Supported Component Evolution (Thomas Genßler and Benedikt Schulz) .... 175
Automated Application of Design Patterns to Legacy Code (Mel Ó Cinnéide and Paddy Nixon) .... 175
Tool Support for Refactoring Duplicated OO Code (Matthias Rieger, Stéphane Ducasse, and Georges Golomingi) .... 176
Extracting Architecture: The Behavioural Point of View (Xavier Alvarez and Isabelle Borne) .... 178
Report of Working Group on Metrics, Visualisation, and Problem Detection (Oliver Ciupke) .... 179
Report of Working Group on Refactorings, UML Extraction, and Frameworks (Re)-documentation (Stéphane Ducasse) .... 181

**Component-Oriented Programming** .... 184
*Clemens Szyperski, Jan Bosch, and Wolfgang Weck*
Dimensions of Component Based Development (Colin Atkinson, Thomas Kühne, and Christian Bunse) .... 185
Specification of Behaviour in Component Frameworks (Günter Graw) .. 186
Component Trading: The Basis for a Component-Oriented Development Framework (Sotirios Terzis and Paddy Nixon) .... 186
An Aspect-Oriented Design Framework for Concurrent Systems (Constantinos Constantinides, Atef Bader, and Tzilla Elrad) .... 186
Three Features for Component Frameworks (James Noble) .... 186
A Component-Based Dataflow Framework for Simulation and Visualization (Alexandru Telea) .... 187
COM Support in BETA (Ole Lehrmann Madsen) .... 187
Black-Box Program Specialization (Ulrik Pagh Schultz) .... 187
Proposal for Tools Supporting Component Based Programming (Henrik Lykke Nielsen and Rene Elmstrom) .... 187
Correct Composition of Design Components (Jing Dong, Paulo S.C. Alencar, and Donald D. Cowan) .... 188

Coarse-Grained Components as an Alternative to Component Frameworks (David Helton) . . . . . 188

**Object Technology for Product-Line Architectures** . . . . . 193
*Philippe Lalanda, Jan Bosch, Ramon Lerchundi, and Sophie Cherki*

Creating Malleable Architectures for Application Software Product Families (Ramkumar Ramaswamy and Uttara Nerurkar) . . . . . 197

Building Product-Lines with Mixin-Layers (Don Batory and Yannis Smaragdakis) . . . . . 197

Standardizing Component Interaction Patterns in Product-Lines Architectures (Bo Nørregaard Jorgensen and Wouter Joosen) . . . . 197

Speeding up the Java Serialization Framework through Partial Evaluation (Mathias Braux) . . . . . 198

The Effect of Standardization on Product Development (Mikko Hämäläinen and Juha Savolainen) . . . . . 198

From Product-Line Architectures to Products (Sholom Cohen) . . . . . 198

Managing Object-Oriented Frameworks with Specialization Templates (Markku Hakala, Juha Hautamaki, Jyrki Tuomi, Antti Viljamaa, Jukka Viljamma, Kai Koskimies, and Jukka Paakki) . . . . . 199

UML for Describing Product-Line Architectures? (Perdita Stevens) . . . 199

Requirements Traceability for Product-Lines (Renato Vinga-Martins) . . 199

A ROOM Framework for the Spectrometer Controller Product-Line (Tuomas Ihme) . . . . . 200

Analysing Hot/Frozen Spot from Performance Aspect (Tomoji Kishi and Natsuko Noda) . . . . . 200

CCT: A Component-Based Product Line Architecture for Satellite-Based Command and Control Systems (Clifford Hollander and John Ohlinger) . . . . . 201

**Object-Oriented Databases** . . . . . 207
*Giovanna Guerrini, Isabella Merlo, Elena Ferrari, Gerti Kappel, and Adoracion de Miguel*

Object Databases and Petabyte Storage - Dreams or Reality? (Dirk Düllmann and Jamie Shiers) . . . . . 210

Evaluation for Evolution: How Well Commercial Systems Do (Awais Rashid and Peter Sawyer) . . . . . 210

Evolutionary Data Conversion in the PJama Persistent Language (Misha Dmitriev and Malcom P. Atkinson) . . . . . 211

Transparent, Scalable, Efficient OO-Persistence (Stephan Korsholm) . . . 212

Distributed Mediation Using a Light-Weight OODBMS (Vanja Josifovski and Tore Risch) . . . . . 213

VOODOO: A Visual Object-Oriented Database Language for ODMG OQL (Leonidas Fegaras) . . . . . 213

Outdating Outdated Objects (Holger Riedel) . . . . . 214

Retrieval of Information from Temporal Document Databases (María José Aramburu Cabo and Rafael Berlanga Llavori) . . . . . 214

Consistency Management in Object-Oriented Databases (Hussien Oakasha, Stefan Conrad, and Gunter Saake) .......... 216

Compensation Methods to Support Generic Graph Editing: A Case Study in Automated Verification of Schema Requirements for an Advanced Transaction Model (Susan Even and David Spelt) .... 216

**Parallel/High-Performance Object-Oriented Scientific Computing** .......... 222

*Bernd Mohr, Federico Bassetti, Kei Davis (Organizers), Stefan Hüttemann, Pascale Launay, Dan C. Marinescu, David J. Miller, Ruthe L. Vandewart, Matthias Müller, and Augustin Prodan*

Object-Oriented Concepts for Parallel Smoothed Particle Hydrodynamics Simulations (Stefan Hüttemann) .......... 223

Molecular Dynamics with C++. An Object-Oriented Approach (Matthias Müller) .......... 225

An Agent-Based Design for Problem Solving Environments (Dan C. Marinescu) .......... 228

An Object-Based Metasystem for Distributed High Performance Simulation and Product Realization (David J. Miller and Ruthe L. Vandewart) .......... 230

Using Collections to Structure Parallelism and Distribution (Pascale Launay) .......... 232

Simulating and Modeling in Java (Augustin Prodan) .......... 234

Requirements/Issues for (Performance) Tools for C++ and Java (Bernd Mohr) .......... 236

**Integrating Human Factors into Use Cases and Object-Oriented Methods** .......... 240

*Ahmed Seffah and Cameron Hayne*

Detailing Use-Cases with Activity Diagrams and Object Views (Nuno Jardim Nunes and João Falcão e Cunha) .......... 241

Integration of the User Model and Human Factors in an Object Oriented Software Production Environment (María Dolores Lozano and Isidro Ramos) .......... 242

The Requirements/Service/Interface (RSI) Approach to Use Case Analysis (Mark Collins-Cope) .......... 243

The Knight Project: Tool Support for Cooperation in Object-Oriented Modelling (Klaus Marius Hansen) .......... 244

Characterizing Task Formalisms: Towards a Taxonomy (Sandrine Balbo, Cécile Paris, and Nadine Ozkan) .......... 246

Use Cases and Task Analysis (Elizier Kantorowitz) .......... 247

Comparing Use Cases and Task Analysis: A Concrete Example (Cameron Hayne, Ahmed Seffah, and Daniel Engelberg) .......... 248

Use-Case Storyboards in the Rational Unified Process (Philippe Kruchten) .......... 249

Relations between Use Cases and Task Analysis (Peter Forbrig and Anke Dittmar) .......... 250

Enhancing Use Case Driven Process with Elements of a User-Centered Requirements Framework (Rachida Djouab, Ahmed Seffah, Moncef Bari, and Ghislain Lévesque) .......... 252

**Object-Oriented and Constraint Programming for Time Critical Applications** .......... 255

*Frank S. de Boer*

A Truly Concurrent Semantics for Timed Default Concurrent Constraint Programming (S. Tini and A. Maggiolo-Schettini) .... 256

Specialising Finite Domain Programs Using Polyhedra (Jacob M. Howe and Andy King) .......... 258

Transparent Process Replication in a Shared Data Space Architecture for Distributed Systems (Paul Dechering and Edwin de Jong) .... 259

From Solver Collaboration Expressions to Communicating and Coordinated Agents (Eric Monfrey) .......... 260

On-the-Fly Model Checking of CTL Formulas Using Constraint Logic Programming (J. Leubcke and Ulf Nilsson) .......... 261

On the Expressiveness of Concurrent Constraint Languages (M. Chiara Meo) .......... 261

Redesigning Constraint Based Applications with Aspects (JanaDospisil and Elizabeth Kendall) .......... 265

Failure Semantics for the Exchange of Information in Multi-agent Systems (Frank S. de Boer, R.M. van Eijk, W. van der Hoek, and John Jules Meyer) .......... 265

**Interactive System Design and Object Models** .......... 267

*Nuno Jardim Nunes, Marco Toranzo, João Falcão e Cunha, Jaelson Castro, Srdjan Kovacevic, Dave Roberts, Jean-Claude Tarby, Mark Collins-Cope, and Mark van Harmelen*

When the Task's World Meets the Object's World (Jean-Claude Tarby) 281

Automatic Acquisition of Task Models from Object Oriented Design Specifications: A Case Study (Shijian Lu and Cécile Paris) ..... 281

Domain Object Models and User-Interfaces (Michael Thomsen) ....... 282

Some Observations on the Relationships between Tasks Use Cases Scenarios and Requirements Models (Elizier Kantorowitz) ....... 282

A Bridge too Far: The WISDOM Approach (Nuno Nunes and João Falcão e Cunha) .......... 283

The RSI Approach to Use Case Analysis: A ProtoPattern for Structured Use Case Development (Mark Collins-Cope) ........ 283

A Comprehensive Traceability Model to Support the Design of Interactive Systems (Marco Toranzo and Jaelson Castro) ........ 283

Adaptability Problems of Architectures for Interactive Software (Marc Evers) .......... 284

Characterizing User Interface Components for Reuse (Richard Cooper and Philip Gray) . . . 284
Designing Synchronous User Interface for Collaborative Applications (Antonio Mendes da Silva Filho and Hans Kurt E. Lisenberg) . . . 285

**Aspect-Oriented Programming** . . . 288
*Lodewijk Bergmans and Cristina Videira Lopes (Editors)*
The Role of the Base in Aspect Oriented Programming (John Lamping) . . . 289
An Aspect Language for Robust Programming (Pascal Fradet and Mario Südholt) . . . 291
JST: An Object Synchronisation Aspect for Java (Lionel Seinturier) . . . 292
Is Domain Knowledge an Aspect? (Maja D'Hondt and Theo D'Hondt) . . . 293
Aspect-Oriented Programming for Role Models (Elizabeth A. Kendall) 293
Aspect-Orientated Process Engineering (Simon Thompson and Brian Odgers) . . . 294
A Tool Suite to Support Aspect-Oriented Specification (Lynne Blair and Gordon Blair) . . . 296
Explicit Aspect Composition by Part-Whole State Charts (Luca Pazzi) 297
Separating Concerns Throughout the Development Lifecycle (Siobhán Clarke, William Harrison, Harold Ossher, and Peri Tarr) 299
Extending UML with Aspects: Aspect Support in the Design Phase (Junichi Suzuki and Yoshikazu Yamamoto) . . . 299
A Reflective Architecture for the Support of Aspect-Oriented Programming in Smalltalk (Jane Pryor and Natalio Bastán) . . . 300
On Weaving Aspects (Kai Böllert) . . . 301
An Aspect-Oriented Design Framework for Concurrent Systems (Constantinos Constantinides, Atef Bader, and Tzilla Elrad) . . . 302
Runtime Implementation of Aspects Using Kava (Ian Welch and Robert J. Stroud) . . . 303
Aspect-Oriented Programming in BETA Using the Fragment System (Jørgen Knudsen) . . . 304
On the Role of Method Families for Aspect-Oriented Programming (Katharina Mehner and Annika Wagner) . . . 305
Adaptation of Functional Object Programs (Ralf Lämmel, Günter Riedewald, and Wolfgang Lohmann) . . . 306
Formalising Composition Oriented Programming (Mark Skipper and Sophia Drossopoulou) . . . 307
Aspects and Superimpositions (Shmuel Katz and Joseph Gil) . . . 308
Wrap-Up (Gregor Kiczales) . . . 309

**Semantics of Objects as Processes (SOAP)** . . . 314
*Uwe Nestmann and António Ravara*
Piccola — A Small Composition Language (Oscar Nierstrasz) . . . 317
The $\pi L$-Calculus — A Formal Foundation for Software Composition (Markus Lumpe) . . . 317

Object Models in the $\pi L$-Calculus (Jean-Guy Schneider) . . . . . . . . . . . 318
Composing Object-Oriented Specifications and Verifications with cTLA (Günter Graw, Peter Herrmann, and Heiko Krumm) . . . . . . . . . . 318
A Practical Approach to Behavioural Inheritance in the Context of Coloured Petri Nets (Charles Lakos and Glenn Lewis) . . . . . . . . . . 320
Behavioural Types in CoOperative Objects (Nabil Hameurlain and Christophe Sibertin-Blanc) . . . . . . . . . . . . . 320
A Concurrent Object Calculus with Types that Express Sequences (Christof Peter and Franz Puntigam) . . . . . . . . . . . . . . . . . . . . . . . . 321
Explicit Behavioral Typing for Object Interfaces (Elie Najm and Abdelkrim Nimour) . . . . . . . . . . . . . . . . . . . . . . . . . . 321

**Quantitative Approaches in Object-Oriented Software Engineering** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 326
*Fernando Brito e Abreu, Horst Zuse, Houari Sahraoui, and Walcelio Melo*
Modeling and Measuring Object-Oriented Software Attributes with Proximity Structures (Geert Poels and Guido Dedene) . . . . . . . . . . 328
The GOODLY Design Language for MOOD2 Metrics Collection (Fernando Brito e Abreu, Luis Ochoa, and Miguel Goulao) . . . . . . . 328
Software Metrics and Object-Oriented Systems (Horst Zuse) . . . . . . . . . . 329
Demo of a Tool for OO Metrics Collection (Brian Henderson-Sellers) . . 329
Towards the Measurement of Reuse by Inheritance in Legacy Systems (Radu Marinescu) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 330
Using Metrics for Refactoring (Houari A. Sahraoui, T. Miceli, and R. Godin) . . . . . . . . . . . . . . . . . . 330
An Hypothesis-Based Evaluation of an Object-Oriented Inheritance Metric (Steve Counsell, P. Newson, and K. Mannock) . . . . . . . . . . . 331
Validation of Metrics for Object-Relational Databases (Coral Calero, Mario Piattini, Francisco Ruiz, and Macario Polo) . 331
Representation of High Level Models for Reuse (Soliman M. Algeri and Ian Finch) . . . . . . . . . . . . . . . . . . . . . . . . . . . 333
Measuring the Impact of Migration to an Object Oriented Paradigm (David John Leigh, Colin J. Theaker, Neil Blackwood, and Robert Mason) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 334
Towards Techniques for Improved OO Design Inspections (Forrest Shull, Guilherme H. Travassos, and Victor Basili) . . . . . . . 334
Combining Metrics, Principles, and Guidelines for Object Oriented Design Complexity Reduction (Guilherme H. Travassos and Renata da Silva Andrade) . . . . . . . . . 334

**Introducing OO Design and Programming with Special Emphasis on Concrete Examples** . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 338
*Erzsébet Angster, Joseph Bergin, and László Böszörményi*
Introduction of OO with Bottom-Up Approach, Structured First (László Böszörményi) . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 340

Introduction of OO with Java, Objects First (Joseph Bergin) . . . . . . . . . 343
Introduction of Programming with Bottom-Up Approach, Early OO (Erzsébet Angster) . . . . . . . . . . 348
Top-Down Approach, Strong Design (Fernando Brito e Abreu and Miguel Goulão) . . . . . . . . . . 351
Laying the Foundations Is Essential (Beáta Kelemen) . . . . . . . . . . 353
Objects First, Modeling Is Important (Dorris Schmedding) . . . . . . . . . . 354
OO Is Programming in the Large (Christoph Steindl) . . . . . . . . . . 356
Concepts First, Design Later (Raimundas Vaitkevitcius) . . . . . . . . . . 357

**Panel Session: Object Technology and Systematic Reuse** . . . . . . . . . 362
*Sholom Cohen*
Challenges to Object-Oriented Reuse (Krzysztof Czarnecki) . . . . . . . . . 364
A Framework for Software Product Line Practice (Linda Northrop) . . . 365
Product-Line Architectures (Philippe Lalanda) . . . . . . . . . . 366
Deriving Object-Oriented Frameworks from Domain Knowledge (Mehmet Aksit) . . . . . . . . . . 367
Developing Frameworks by Aligning Requirements, Design, and Code (Greg Butler) . . . . . . . . . . 368

**Poster Session** . . . . . . . . . . 371
*Carlos Baquero*
The Oberon Program Slicing Tool (Christoph Steindl) . . . . . . . . . . 371
Aspect-Oriented Programming in Smalltalk (Kai Böllert) . . . . . . . . . . 372
Java Type System with Exceptions (Sophia Drossopoulou et al.) . . . . . . 373
Using Patterns into the Conception of a Medical KBS (Marie Beurton-Aimar et al.) . . . . . . . . . . 374
Validation of Object Oriented Models Using Animation (Ian Oliver et al.) . . . . . . . . . . 375
The BLOOM Model Revisited: An Evolution Proposal (Alberto Abelló et al.) . . . . . . . . . . 376
The COAST Object Database System (Sven-Eric Lautemann, Sabbas Apostolidis, Alexander Doll, and Jan Haase) . . . . . . . . . . 378

**Author Index** . . . . . . . . . . 385