
Contents

1 An Adaptable Service-based Framework for Distributed Product Realization	
<i>Jitesh H. Panchal, Hae-Jin Choi, Janet K. Allen, David Rosen and Farrokh Mistree</i>	1
1.1 Introduction.....	2
1.1.1 Need for an Adaptable Framework.....	3
1.1.2 An Open Engineering Systems Approach.....	3
1.2 Requirements and Features of an Adaptable Framework.....	4
1.3 Review of Capabilities Provided by Existing Frameworks.....	8
1.3.1 Web-based Systems.....	8
1.3.2 Agent-based Systems.....	10
1.3.2.1 Distributed Object-based Modeling and Evaluation (DOME).....	13
1.3.2.2 NetBuilder.....	13
1.3.3.3 Web-DPR.....	14
1.3.3.4 Federated Intelligent Product EnviRonment (FIPER)....	14
1.4 Motivating Example: Design of Linear Cellular Alloys (LCAs).....	15
1.5 X-DPR (eXtensible Distributed Product Realization) Environment.....	17
1.5.1 Overview of X-DPR.....	17
1.5.2 Elements of the Framework.....	18
1.5.2.1 Data Repository.....	20
1.5.2.2 Process Diagram Tool.....	21
1.5.2.3 Dynamic UI Generation.....	23
1.5.2.4 Interface Mapping Tool.....	24
1.5.2.5 Messaging and Agent Description in X-DPR.....	26
1.5.2.6 Publishing a Service.....	26
1.5.2.7 Asset Search Service.....	26
1.5.3 Using the X-DPR framework for LCAs design.....	27
1.5.4 X-DPR as an Adaptable Framework.....	28
1.6 Conclusions.....	30

- 1.7 Acknowledgments 32
- 1.8 References 32

- 2 A Web-based Intelligent Collaborative System for Engineering Design**
Xiaoqing (Frank) Liu, Samir Raorane and Ming C. Leu 37

 - 2.1 Introduction 37
 - 2.2 Related Work..... 38
 - 2.2.1 Current State-of-the-art on Computer-aided Collaborative Engineering Design Systems 38
 - 2.2.2 Current State-of-the-art on Argumentation-based Conflict Resolution 39
 - 2.3 A Web-based Intelligent Collaborative Engineering Design Environment and Its Application Scenarios..... 40
 - 2.4 Argumentation-based Conflict Resolution in the Collaborative Engineering Design Environment 40
 - 2.4.1 Structured Argumentation Through Dialog Graph 42
 - 2.4.2 Argument Reduction Through Fuzzy Inference..... 43
 - 2.4.2.1 Linguistic Variable Through Fuzzy Membership Functions..... 45
 - 2.4.2.2 Fuzzy Inference Rules 46
 - 2.4.2.3 Fuzzy System and Defuzzification 47
 - 2.4.3 Structured Argumentation Through Dialog Graph 49
 - 2.5 Design and Implementation 49
 - 2.6 An Application Example..... 50
 - 2.7 Conclusions..... 56
 - 2.8 Acknowledgements..... 56
 - 2.9 References 57

- 3 A Shared VE for Collaborative Product Development in Manufacturing Enterprises**
G. Chryssoulouris, M. Pappas, V. Karabatsou, D. Mavrikios and K. Alexopoulos..... 59

 - 3.1 Introduction 59
 - 3.2 Background 60
 - 3.3 Building the Shared VE..... 61
 - 3.4 Virtual Environment Functionality 63
 - 3.4.1 Virtual Prototyping Function..... 63
 - 3.4.2 Behavioral Simulation Function 63
 - 3.4.3 Assembly Support Function..... 64
 - 3.4.4 Collision Detection Function 65
 - 3.5 Pilot Application 65
 - 3.6 Conclusions and Future Research 67
 - 3.7 Acknowledgements..... 68
 - 3.8 References 68

4 A ‘Plug-and-Play’ Computing Environment for an Extended Enterprise	
<i>F. Mervyn, A. Senthil Kumar and A. Y. C. Nee</i>	71
4.1 Introduction	71
4.2 Related Research	72
4.3 Application Development Framework	75
4.3.1 Geometric Modeling Middleware Services	77
4.3.1.1 Modeling Functions.....	77
4.3.1.2 Geometric Data XML File	79
4.4.2.3 Application Relationship Manager (ARM)	80
4.3.2 Process Data Exchange Middleware Services	83
4.3.3 Reusable Application Classes	84
4.4 Illustrative Case Study.....	84
4.5 Conclusions	89
4.6 References	90
5 Cooperative Design in Building Construction	
<i>Yuhua Luo</i>	93
5.1 Introduction	93
5.2 System Architecture and Components.....	95
5.2.1 The Cooperative 3D Editor.....	96
5.2.2 The Cooperative Support Platform	98
5.2.3 The Integrated Design Project Database.....	98
5.3 Considerations and Implementation for Collaborative Design.....	99
5.3.1 Interoperative and Multi-disciplinary	99
5.3.2 The On-line Cooperative Working	101
5.3.3 Design Error Detection During Integration	102
5.4 System Evaluation	103
5.5 Conclusions	106
5.6 Acknowledgements	107
5.7 References	107
6 A Fine-grain and Feature-oriented Product Database for Collaborative Engineering	
<i>Y.-S. Ma, S.-H. Tang and G. Chen</i>	109
6.1 Introduction	109
6.2 Generic Feature Model	112
6.2.1 Feature Shape Representation.....	113
6.2.2 Constraint Definition	113
6.2.3 Other Feature Properties	114
6.2.4 Member Functions	115
6.2.5 Application-specific Feature Model	116
6.3 Mapping Mechanisms	116

6.3.1	Mapping from Extended EXPRESS Model to ACIS Workform Format	117
6.3.1.1	Geometry Mapping	117
6.3.1.2	Generic Feature Definition Under ACIS Framework	118
6.3.2	Database Representation Schema	119
6.4	The Integration of Solid Modeler and Database	119
6.4.1	Feature Model Re-evaluation and Constraint Solving	120
6.4.2	Save Algorithm	121
6.4.3	Restore Algorithm	122
6.5	Feature Model Re-evaluation	122
6.5.1	Problems of Historical-dependent System	122
6.5.2	Dynamically Maintaining Feature Precedence Order	124
6.5.3	History-independent Feature Model Re-evaluation	125
6.5.3.1	Adding a New Feature Instance	125
6.5.3.2	Deleting a Feature Instance	126
6.5.3.3	Modifying a Feature Instance	130
6.5.3.4	B-rep Evaluation	130
6.6	A Case Study	130
6.7	Conclusions	133
6.8	Acknowledgements	134
6.9	References	134
7	A Web-based Framework for Distributed and Collaborative Manufacturing	
	<i>M. Mahesh, S. K. Ong and A. Y. C. Nee</i>	137
7.1	Introduction	137
7.2	Distributed and Collaborative Manufacturing	139
7.3	Proposed Framework and Implementation	140
7.4	A Case Study	142
7.5	Conclusions	148
7.6	References	148
8	Wise-ShopFloor: A Portal toward Collaborative Manufacturing	
	<i>Lihui Wang</i>	151
8.1	Introduction	151
8.2	Enabling Technologies	152
8.3	Wise-ShopFloor Framework	153
8.4	Adaptive Process Planning and Scheduling	155
8.4.1	Architecture Design	155
8.4.2	Machining Process Sequencing	156
8.4.3	Function Block Design And Utilization	158
8.4.4	Shop Floor Integration	163
8.5	Web-based Real-time Monitoring and Control	164
8.5.1	System Configuration	164
8.5.2	Sensor Data Collection for Real-Time Monitoring	165

8.5.3	Data Packet Format.....	167
8.5.4	Java 3D Enabled Visualization	167
8.5.5	Web-based Remote CNC Control.....	169
8.6	A Case Study.....	169
8.7	Conclusions	172
8.8	Acronyms	173
8.9	References	174
9	Real Time Distributed Shop Floor Scheduling: An Agent-Based Service-Oriented Framework	
	<i>Chun Wang, Kewei Li, Hamada Ghenniwa, Weiming Shen and Ying Wang</i>	175
9.1	Introduction	175
9.2	Scheduling Problems in Multiple Workcell Shop Floor.....	176
9.2.1	Workcell Scheduling Problem	177
9.2.2	Dynamic Scheduling Problem	179
9.2.3	Distributed Scheduling Problem	180
9.3	Scheduling Algorithms for Multiple Workcell Shop Floor	181
9.3.1	Workcell Scheduling Algorithm	182
9.3.2	Dynamic Scheduling Algorithm	183
9.3.3	Distributed Scheduling Algorithm.....	185
9.4	Agent-Based Service-Oriented System Integration	187
9.4.1	System Overview	188
9.4.2	Dynamic Scheduling Algorithm	189
9.4.3	Scheduler Agent Design	190
9.4.4	Coordination between Scheduler Agent and Real Time Controller Agent.....	191
9.4.5	Coordination between Scheduling Services.....	192
9.4.6	System Implementation	194
9.5	A Case Study	194
9.6	Conclusions	195
9.7	References	197
10	Leveraging Design Process Related Intellectual Capital – A Key to Enhancing Enterprise Agility	
	<i>Jitesh H. Panchal, Marco Gero Fernández, Christiaan J. J. Paredis, Janet K. Allen and Farrokh Mistree</i>	201
10.1	Design Processes – An Enterprise’s Fundamental Intellectual Capital.....	202
10.2	Examples of Design Process Scenarios	204
10.2.1	Description of LCAs design problem	205
10.2.2	LCAs design process strategies	206
10.2.2.1	Strategy 1: Sequential Design – Thermal First.....	206
10.2.2.2	Strategy 2: Sequential Design – Structural First.....	207
10.2.2.3	Strategy 3: Set-based Design.....	207

- 10.2.2.4 Strategy 4: Use of Surrogate Models..... 207
- 10.2.2.5 Strategy 5: Parallel Iterative Design..... 208
- 10.3 Requirements and Critical Issues for Leveraging Design Process
 - Related Intellectual Capital..... 209
 - 10.3.1 Support for Design Information Transformations..... 209
 - 10.3.2 Support for Design Decision-making 210
 - 10.3.3 Modeling and Representation of Design Processes 210
 - 10.3.4 Analyzing Design Processes 211
 - 10.3.5 Synthesizing Design Processes 211
- 10.4 Research Issues and Strategies for Designing Design Processes 212
 - 10.4.1 Modeling Design Processes 214
 - 10.4.1.1 Research Issue 214
 - 10.4.1.2 Previous Work..... 214
 - 10.4.1.3 Research Questions 214
 - 10.4.1.4 Strategy: a Decision-centric Approach..... 214
 - 10.4.2 Computational Representations for Design Processes..... 216
 - 10.4.2.1 Research Issue 216
 - 10.4.1.2 Previous Work..... 216
 - 10.4.1.3 Research Questions 217
 - 10.4.1.4 Strategy: Separating Declarative Information from
Procedural Information 217
 - 10.4.3 Storage of Design Information..... 218
 - 10.4.3.1 Research Issue 218
 - 10.4.3.2 Previous Work..... 218
 - 10.4.3.3 Research Questions 219
 - 10.4.3.4 Strategy: Process Templates..... 219
 - 10.4.4 Developing metrics for assessing design processes 220
 - 10.4.4.1 Research Issue 220
 - 10.4.4.2 Previous Work..... 221
 - 10.4.3.3 Research Questions 221
 - 10.4.3.4 Strategy: Process Templates..... 221
 - 10.4.5 Configuring Design Processes 222
 - 10.4.5.1 Research Issue 222
 - 10.4.5.2 Previous Work..... 222
 - 10.4.5.3 Research Questions 222
 - 10.4.5.4 Strategy: Process Families..... 223
 - 10.4.6 Configuring Design Processes 223
 - 10.4.6.1 Research Issue 223
 - 10.4.6.2 Previous Work..... 224
 - 10.4.6.3 Research Questions 224
 - 10.4.6.4 Strategy: Identifying Process Decisions 224
 - 10.4.7 Integrating Design Processes with Other Processes in PLM 225
 - 10.4.7.1 Research Issue 225
 - 10.4.7.2 Previous Work..... 225
 - 10.4.7.3 Research Questions 226
 - 10.4.7.4 Strategy: a Decision-centric Approach..... 226
- 10.5 Conclusions..... 227

10.6 Acknowledgments.....	228
10.7 References	228
11 Manufacturing Information Organization in Product Lifecycle Management	
<i>R. I. M. Young, A. G. Gunendran and A. F. Cutting-Decelle</i>	<i>235</i>
11.1 Introduction	235
11.2 Information and Knowledge Infrastructures for Manufacture.....	236
11.3 Context Awareness: Its Significance for Information Organization.....	239
11.3.1 Product Context	239
11.3.2 Life Cycle Context.....	241
11.3.3 Context Relationships	242
11.4 Exploiting Manufacturing Standards.....	246
11.4.1 STEP for Manufacturing.....	246
11.4.2 Mandate – Resource, Time And Flow Models	247
11.4.3 Process Specification Language	248
11.5 Exploiting Product and Process Knowledge in Future	249
11.6 Conclusions	251
11.7 References	252
12 Semantic Interoperability to Support Collaborative Product Development	
<i>Q. Z. Yang and Y. Zhang.....</i>	<i>255</i>
12.1 Introduction	255
12.2 Semantic Interoperability Concepts and Technologies.....	257
12.2.1 Data-driven Interoperability Standard	258
12.2.2 Ontologies.....	258
12.2.3 Product Models.....	260
12.3 Product Semantics Capturing and STEP Extension Modeling.....	263
12.3.1 Representing Semantics in Supplementary Information Models.....	263
12.3.2 Embedding Supplementary Information in CAD Models.....	264
12.3.3 Modeling STEP Extensions	265
12.3.4 Capturing Semantics in STEP-compliant Product Models	266
12.4 Taxonomy and Ontology	267
12.4.1 Vocabulary Taxonomy	267
12.4.2 OWL Ontology	268
12.5 Semantics-driven Schema Mapping	270
12.6 Software Prototype Development.....	272
12.6.1 Software System Architecture	272
12.6.2 Client Toolkits	273
12.6.3 Collaboration Server Components and Services.....	276
12.7 Collaboration Scenarios.....	278
12.7.1 Support of Collaborative Design Process	278
12.7.2 Design Objects Modeling and Semantics Capturing	279

- 12.7.3 Semantics Sharing with Heterogeneous Systems 281
- 12.8 Conclusions 283
- 12.9 Acknowledgements 284
- 12.10 Acronyms 284
- 12.11 References 284

- 13 A Proposal of Distributed Virtual Factory for Collaborative
Production Management**
- Toshiya Kaihara, Susumu Fujii and Kentaro Sashio* 287

- 13.1 Introduction 287
- 13.2 Distributed Virtual Factory 288
 - 13.2.1 Concept 288
 - 13.2.2 Structure 289
 - 13.2.3 Time Bucket Mechanism 289
- 13.3 Cost Analysis 291
 - 13.3.1 Cost Analysis In Manufacturing Systems 291
 - 13.3.2 Activity Based Costing (ABC) 291
 - 13.3.3 DVF and ABC 292
 - 13.3.4 Manufacturing Model 292
 - 13.3.5 Formulations for Cost 292
- 13.4 Experimental Results 297
 - 13.4.1 Simulation Model 297
 - 13.4.2 Total Factory Management in DVF 297
 - 13.4.3 Cost Analysys 300
- 13.5 Conclusions 301
- 13.6 References 303

- Index** 305