
Contents

1 An Adaptable Service-based Framework for Distributed Product Realization

Jitesh H. Panchal, Hae-Jin Choi, Janet K. Allen, David Rosen

<i>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	
	<i>Xiaoqing (Frank) Liu, Samir Raorane and Ming C. Leu</i>	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	
	<i>G. Chryssolouris, M. Pappas, V. Karabatsou, D. Mavrikios and K. Alexopoulos</i>	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

Chun Wang, Kewei Li, Hamada Ghenniwa, Weiming Shen

and Ying Wang..... 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

Jitesh H. Panchal, Marco Gero Fernández, Christiaan J. J. Paredis,

Janet K. Allen and Farrokh Mistree 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	
<i>Toshiya Kaihara, Susumu Fujii and Kentaro Sashio</i>	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

Collaborative Product Design and Manufacturing
Methodologies and Applications

Li, W.D.; Ong, S.K.; Nee, A.Y.C.; McMahon, C.A. (Eds.)

2007, XIV, 308 p., Hardcover

ISBN: 978-1-84628-801-2