Contents

1 Product Design as Integration of Axiomatic Design and Design Structure Matrix 1
1.1 Introduction and Synopsis. 1
1.2 Axiomatic Design Versus Design Structure Matrix. 2
1.2.1 Advantages and Disadvantages of Axiomatic Design . . . 2
1.2.2 Advantages and Disadvantages of Design Structure Matrix 4
1.2.3 The Benefit of Combining Axiomatic Design and Design Structure Matrix 5
1.3 The Theory of Axiomatic Design and Design Structure Matrix Integration 6
1.3.1 Formulation of Related Predicates. 6
1.3.2 Recursive Interaction of DM and DSM. 9
1.4 System Development and Application 13
1.4.1 System Development. 13
1.4.2 Application of Integration Between AD and DSM 15
1.5 Conclusion 19
References. 20

2 Product Design Knowledge Management Based on Design Structure Matrix 21
2.1 Introduction and Synopsis. 21
2.2 Related Research of Knowledge Management 22
2.3 KM Lifecycle Framework Based on DSM 23
2.4 Knowledge Acquisition. 25
2.4.1 Direct Knowledge Capture from DSMs. 25
2.4.2 Indirect Knowledge Capture 29
2.5 Knowledge Organization and Application. 30
2.6 Conclusion 33
References. 33

3 Matrix-Based Conceptual Solution Generation Approach of Multifunction Product 35
3.1 Introduction and Synopsis 35
3.2 Related Research of Multifunction Product Design 36
3.3 Function Model 37
3.3.1 Functional Basis 37
3.3.2 Construction of Function Model 37
3.4 Conceptual Solution Generation Approach (CSGA) of Multifunction Product 38
3.4.1 Function Analysis 38
3.4.2 Functional Similarity Analysis 40
3.4.3 Component Correlation Analysis 43
3.5 Application of CSGA for Multifunction Product 45
3.5.1 Function Analysis 45
3.5.2 Functional Similarity Analysis 47
3.5.3 Component Correlation Analysis 48
3.6 Results and Discussion 48
3.7 Conclusion 52
References 53

4 Matrix-Based Computational Concept Design with Ant Colony Optimization 55
4.1 Introduction and Synopsis 55
4.2 Related Research of Product Conceptual Design 56
4.3 Tools Used in Matrix-Based Conceptual Generation 57
4.3.1 Functional Basis of Design 58
4.3.2 Function–Component Repository 58
4.3.3 Function–Component Repository 59
4.3.4 Ant Colony Optimization 60
4.4 Matrix-Based Concept Generation Method (MCGM) 61
4.4.1 Function Decomposition and Generation of Sub-function Chain 62
4.4.2 Generation of FCM 63
4.4.3 Generation of Initial Solution Matrix 64
4.4.4 Definition of Component–Component Matrix 65
4.4.5 Filtration of Initial Conceptual Solution 66
4.4.6 Definition of Evaluation Criteria and Weighting 66
4.4.7 Optimization of Design Solution with ACO 68
4.5 Application of MCGM for Product Design 75
4.6 Conclusion and Future Work 79
References 80

5 Workload-Based Change Propagation Analysis in Product Design 83
5.1 Introduction and Synopsis. 83
5.2 Related Research of Engineering Change 84
5.3 Outline of the Method 86
5.4 Searching Change Propagation Paths 88
5.4.1 Mapping from Change Requirements to Product Components. 88
5.4.2 Relationships Between Product Components 89
5.4.3 Change Propagation Pattern. 90
5.4.4 Searching Change Propagation Paths. 92
5.5 Workload-Based Analysis of Change Propagation 96
5.5.1 Workload Transformation Within a Change Propagation Step 96
5.5.2 Workload for a Change Propagation Path 98
5.5.3 Change Propagation Analysis and Recommendation 99
5.6 Application of the Method for Product Design 101
5.6.1 Modeling Process 102
5.6.2 Searching Change Propagation Paths. 103
5.6.3 Workload-Based Analysis of Change Propagation. 103
5.7 Initial Evaluation 105
5.8 Discussion 106
5.9 Conclusion and Future Work 107
References. 108

6 Matrix-Based Engineering Change Management of Product Design Using MBD Technique 111
6.1 Introduction and Synopsis. 111
6.2 Design Change-Oriented MBD Model 112
6.3 Change Acquisition in Terms of Product Parameter 114
6.3.1 Type of Parameter. 114
6.3.2 Parameter Change Acquisition. 114
6.4 Change Acquisition in Terms of Product Assembly 117
6.4.1 Topological Decomposition of Part 117
6.4.2 Topology Face Change Acquisition. 118
6.5 Relation Model for MBD-Based Change Propagation Analysis 124
6.5.1 Parameter Relation 124
6.5.2 Topology Face Relation 126
6.6 Change Propagation Analysis 131
6.6.1 Type of Change Propagation 132
6.6.2 Change Propagation Pattern. 132
6.6.3 Design Change Process 133
6.7 Application of MBD-Based Change Management 137

6.8 Discussions . . . 142
6.9 Conclusion and Future Work . . . 143
References . . . 144

7 Matrix-Based Change Prediction and Analysis Method Considering Multiple Change Requirements . . . 145
7.1 Introduction and Synopsis . . . 145
7.2 Related Literature . . . 147
7.2.1 Change Propagation Mechanism in Product Structure . . . 148
7.2.2 Engineering Change Requirement and Its Role . . . 149
7.2.3 Research Motivation . . . 150
7.3 Multiple Change Requirements Model . . . 150
7.3.1 Assumptions . . . 150
7.3.2 Description of the Proposed Model . . . 151
7.3.3 Change Propagation Pattern Based on Logic Relationship Between Components . . . 152
7.4 Change Risk Propagation and Assessment . . . 153
7.4.1 Change Propagation Mathematical Model for Multiple Change Requirements . . . 153
7.4.2 Illustration of the Proposed Mathematical Model . . . 157
7.5 Cost-Effective CPPs Taking MCRs into Consideration . . . 163
7.6 Application of MRC-Algorithm . . . 166
7.6.1 Change Requirement Scenario . . . 169
7.7 Conclusion and Future Work . . . 176
References . . . 182

8 Product-Oriented Change Propagation and Prediction Approach in Product Family Design . . . 185
8.1 Introduction and Synopsis . . . 185
8.2 Engineering Change in Product Family Design . . . 187
8.3 State-of-the-Art Approach . . . 189
8.3.1 Change Propagation Mechanism in Product Family . . . 189
8.3.2 Change Propagation Pattern and Mathematical Model . . . 192
8.4 Advanced Algorithm for Change Prediction in Product Family . . . 192
8.5 Case Study . . . 194
8.5.1 Change Propagation Analysis in a Business Kettle . . . 195
8.5.2 Change Propagation Analysis in an Office Kettle . . . 199
8.5.3 Change Propagation Analysis in a Home Kettle . . . 200
8.5.4 Change Propagation Analysis in a Product Family Design of Electric Kettle . . . 204
8.6 Conclusion and Future Work . . . 206
References . . . 207

http://www.springer.com/978-981-10-5076-3

Matrix-based Product Design and Change Management
Tang, D.; Yin, L.; Ullah, I.
2018, VIII, 208 p. 133 illus., 99 illus. in color., Hardcover
ISBN: 978-981-10-5076-3