Design Research in Information Systems

Theory and Practice

Forewords by Paul Gray and Carliss Y. Baldwin
# Contents

1 Introduction to Design Science Research ............................................. 1  
1.1 What Is Design? – Different Perspectives ........................................ 1  
1.2 What Is Research? ........................................................................ 2  
1.3 Is Design a Science? ................................................................... 3  
1.4 What Is Design Science Research? .............................................. 5  
1.5 Placing DSR in Context ................................................................ 5  
1.6 The Spectrum of IS DSR ............................................................... 6  
1.7 Difference Between Routine Design Practice and DSR ................. 7  
1.8 Conclusions .............................................................................. 8  
References ....................................................................................... 8  

2 Design Science Research in Information Systems .................................. 9  
2.1 Information Systems Research ...................................................... 9  
2.2 Summary of Hevner, March, Park, and Ram 2004 MISQ Paper ......... 10  
2.3 Impacts of 2004 MISQ Paper on Design Science Research .......... 13  
2.4 Extending the Reach of Design Science Research in IS ................ 14  
2.4.1 Design Science Research vs. Professional Design .................... 15  
2.4.2 Design as Research vs. Researching Design ............................. 15  
2.4.3 Design Science Research Cycles ............................................. 16  
2.4.4 A Checklist for Design Science Research ................................. 19  
2.4.5 Publication of Design Science Research ................................ 19  
References ....................................................................................... 21  

3 Design Science Research Frameworks ................................................. 23  
3.1 Understanding the Natural and Artificial Worlds ............................ 23  
3.2 Toward a Theory of Complex Systems .......................................... 24  
3.3 Systems Development in Information Systems Research ............. 25  
3.4 The General Design Cycle ............................................................ 26  
3.5 Action Research Framework ......................................................... 27  
3.6 The Design Science Research Methodology (DSRM) .................... 28  
3.7 Concluding Thoughts .................................................................. 31  
References ....................................................................................... 31
4 On Design Theory .................................................. 33
  4.1 What Is Theory? ............................................... 33
  4.2 Cycle of Theory Building ................................... 34
     4.2.1 Observation ........................................... 34
     4.2.2 Classification ........................................ 35
     4.2.3 Defining Relationships ............................... 35
     4.2.4 Anomaly – Improving Descriptive Theory ........... 36
  4.3 Transition to Normative Theory ............................ 36
  4.4 Taxonomy of Theory Types in Information Systems ..... 37
  4.5 Is Design Theory Possible? ................................. 38
     4.5.1 Information Systems Design Theory ................ 39
     4.5.2 Hooker’s View on Design Theory .................... 40
     4.5.3 Toward the Anatomy of an IS Design Theory ....... 41
  4.6 Conclusions .................................................. 42
References ........................................................... 42

5 Twelve Theses on Design Science Research in Information Systems ............................................. 43
  5.1 Introduction .................................................. 43
  5.2 Thesis 1: IS Is an Applied or Practical Discipline .... 44
  5.3 Thesis 2: Prescriptive Research Is an Essential Part of IS as an Applied or Practical Discipline .... 45
  5.4 Thesis 3: The Design Science Activity of Building IT Artifacts Is an Important Part of Prescriptive Research in Information Systems ............................................. 47
  5.5 Thesis 4: The Primary Interest of IS Lies in IT Applications, and Therefore IS as a Design Science Should Be Based on a Sound Ontology of IT Artifacts and Especially of IT Applications ............................................. 48
  5.6 Thesis 5: IS as a Design Science Builds IT Meta-artifacts That Support the Development of Concrete IT Applications ................................................................. 49
  5.7 Thesis 6: Prescriptive Knowledge of IT Artifacts Forms a Knowledge Area of Its Own and Cannot Be Reduced to the Descriptive Knowledge of Theories and Empirical Regularities ................................................................. 50
  5.8 Thesis 7: The Resulting IT Meta-artifacts Essentially Entail Design Product and Design Process Knowledge ................................................................. 51
  5.9 Thesis 8: The Term “Design Theory” Should Be Used Only When It Is Based on a Sound Kernel Theory ................................................................. 52
  5.10 Thesis 9: Constructive Research Methods Should Make the Process of Building IT Meta-artifacts Disciplined, Rigorous, and Transparent ................................................................. 53
5.11 Thesis 10: Explication of the Practical Problems to Be Solved, the Existing Artifacts to Be Improved, the Analogies and Metaphors to Be Used, and/or the Kernel Theories to Be Applied Is Significant in Making the Building Process Disciplined, Rigorous, and Transparent 55

5.12 Thesis 11: IS as a Design Science Cannot Be Value-Free, but It May Reflect Means-End, Interpretive, or Critical Orientation 57

5.13 Thesis 12: The Values of Design Science Research Should Be Made as Explicit as Possible 58

5.14 Conclusions and Final Comments 58

References 60

6 A Science of Design for Software-Intensive Systems 63

6.1 Science of Design Challenges 63

6.2 Software-Intensive Systems 65

6.3 Science of Design Principles 66

6.4 Categories of Software-Intensive Systems Principles 68

6.5 A Proposed Research Vision 69

6.6 SIS Scientific Theories 70

6.6.1 Software Design Theories 70

6.6.2 Dynamic System Theories 71

6.6.3 Socio-economic Theories 72

6.6.4 Domain Theories 72

6.7 SIS Engineering Activities 72

6.8 SIS Research Project Framework 74

6.9 Intellectual Drivers for Science of Design in SIS Research 75

References 76

7 People and Design 79

7.1 Designing for Consumers 80

7.2 Practice of Ethnography in Design 81

7.3 Reflection in Action (Schon’s View) 83

7.4 Designing for Scale – Google and People 83

References 86

8 Software Design: Past and Present 87

8.1 A Software Design Framework 87

8.2 Software Architecture 88

8.2.1 Manual Business Processes 89

8.2.2 Mainframe Architectures 89

8.2.3 Online, Real-Time Architectures 89

8.2.4 Distributed, Client-Server Architectures 90

8.2.5 Component-Based Architectures 91

8.2.6 Service-Oriented Architectures 92

8.3 Algorithmic Design 92
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.3.1</td>
<td>Early Program Design</td>
<td>93</td>
</tr>
<tr>
<td>8.3.2</td>
<td>Structured Program Design</td>
<td>93</td>
</tr>
<tr>
<td>8.3.3</td>
<td>Recent Algorithm Design Paradigms</td>
<td>94</td>
</tr>
<tr>
<td>8.3.4</td>
<td>Widely Used Programming Languages</td>
<td>94</td>
</tr>
<tr>
<td>8.4</td>
<td>Data Design</td>
<td>95</td>
</tr>
<tr>
<td>8.4.1</td>
<td>Punched Card Data Management</td>
<td>95</td>
</tr>
<tr>
<td>8.4.2</td>
<td>Computerized File Management</td>
<td>95</td>
</tr>
<tr>
<td>8.4.3</td>
<td>Online Data Processing</td>
<td>96</td>
</tr>
<tr>
<td>8.4.4</td>
<td>Relational Databases</td>
<td>97</td>
</tr>
<tr>
<td>8.4.5</td>
<td>Current Trends in Data Management</td>
<td>97</td>
</tr>
<tr>
<td>8.5</td>
<td>Human–Computer Interaction (HCI) Design</td>
<td>98</td>
</tr>
<tr>
<td>8.5.1</td>
<td>Early Computer Interactions</td>
<td>98</td>
</tr>
<tr>
<td>8.5.2</td>
<td>Text-Based Command Interfaces</td>
<td>98</td>
</tr>
<tr>
<td>8.5.3</td>
<td>The WIMP Interface</td>
<td>99</td>
</tr>
<tr>
<td>8.5.4</td>
<td>Current Trends in HCI</td>
<td>99</td>
</tr>
<tr>
<td>8.6</td>
<td>Software Development Processes and Methods</td>
<td>100</td>
</tr>
<tr>
<td>8.6.1</td>
<td>Software Development Processes</td>
<td>101</td>
</tr>
<tr>
<td>8.6.2</td>
<td>Early Development Methods</td>
<td>102</td>
</tr>
<tr>
<td>8.6.3</td>
<td>Object-Oriented Methods</td>
<td>102</td>
</tr>
<tr>
<td>8.6.4</td>
<td>Formal Development Methods</td>
<td>103</td>
</tr>
<tr>
<td>8.6.5</td>
<td>Component-Based Development (CBD) Methods</td>
<td>103</td>
</tr>
<tr>
<td>8.6.6</td>
<td>Agile Development Methods</td>
<td>104</td>
</tr>
<tr>
<td>8.6.7</td>
<td>Controlled-Flexible Development Methods</td>
<td>104</td>
</tr>
<tr>
<td>References</td>
<td></td>
<td>105</td>
</tr>
</tbody>
</table>

9 Evaluation

9.2 Why Do We Perform Evaluations? | 110 |
9.3 Differing Perspectives of Stakeholders | 111 |
9.4 Basic Structure of Evaluation Studies | 112 |
9.5 The Art of Performance Evaluation | 113 |
9.6 Avoiding Common Mistakes in Performance Evaluation | 115 |
9.7 Conducting an Objectivist Comparative Study – A Brief Example | 115 |
9.8 Threats to Inference and Validity | 118 |
9.9 Conclusions | 119 |
References | 119 |

10 The Use of Focus Groups in Design Science Research

10.1 Introduction | 121 |
10.2 Research Focus Groups | 122 |
10.3 Adapting Focus Groups to Design Research | 124 |
10.3.1 Formulate Research Question or Problem | 124 |
10.3.2 Identify Sample Frame | 126 |
10.3.3 Number of Focus Groups | 126 |
10.3.4 Number of Participants | 127 |
10.3.5 Participant Recruitment .............................................. 127
10.3.6 Identify Moderator ..................................................... 128
10.3.7 Develop and Pre-test a Questioning Route .. 128
10.3.8 Conduct the Focus Group .............................................. 129
10.3.9 Analyze and Interpret Data ........................................... 129
10.3.10 Report Results ........................................................ 130

10.4 A Design Research Example ........................................... 130
10.4.1 Research Context ....................................................... 131
10.4.2 Data Quality Metrics Description ......................... 131
10.4.3 Design Research Questions ........................................ 133
10.4.4 Identify Sample Frame ................................................. 133
10.4.5 Identify Moderator .................................................... 134
10.4.6 Develop a Questioning Route ....................................... 134
10.4.7 Recruit Participants ................................................... 134
10.4.8 Conduct Focus Groups ................................................. 135
10.4.9 Analyze and Interpret the Data .................................... 137
10.4.10 Report Results ........................................................ 138

10.5 Limitations on the Use of Focus Groups for Design Research . 139

10.6 Closing Remarks .......................................................... 140

References ................................................................. 141

11 Design and Creativity ..................................................... 145
11.1 Creativity – What Is It? ................................................... 145
11.2 Group Creativity .......................................................... 147
11.3 Conceptual Blockbusting Theory ................................. 148
11.4 Experiential Learning ..................................................... 150
11.5 Creativity, Design, and IT .............................................. 150
11.6 Creativity and Design in the Age of Virtual Worlds ......... 152
11.7 Designing Virtual Worlds .............................................. 153
11.8 Conclusion ................................................................. 154

References ................................................................. 155

12 A Design Language for Knowledge Management Systems (KMS) . 157
12.1 Problem Statement ......................................................... 157
12.2 Concept ................................................................. 159
12.3 Artifact Construction ..................................................... 162
12.4 Knowledge Packet Generator ........................................... 162
12.5 Barriers ................................................................. 164
12.6 Value Accelerators ........................................................ 165
12.7 Receiver of Good Packets ............................................... 167
12.8 Evaluation Methodology: SME Model Instantiation
   Comparisons ................................................................. 167
12.9 Results ................................................................. 169
12.10 Contribution to Research .............................................. 174
12.11 Conclusion .............................................................. 175

References ................................................................. 176
13 On Integrating Action Research and Design Research ................. 179
13.1 Introduction ............................................. 179
13.2 The Research Approaches .................................. 180
  13.2.1 Design Research ..................................... 180
  13.2.2 Action Research ...................................... 182
13.3 Cross-Application of Criteria ................................ 183
  13.3.1 Applying Action Research Criteria to a Design Research Exemplar . 183
  13.3.2 Applying Design Research Criteria to an Action Research Exemplar . 187
13.4 A Way Forward ............................................ 189
  13.4.1 Adding “Reflection” to Augment Learning from Design Research ........ 190
  13.4.2 Concretizing Learning from Action Research by Adding “Build” ....... 191
  13.4.3 Envisioning an Integrated Research Process ....................... 191
13.5 Conclusions .............................................. 192
References .................................................... 193

14 Design Science in the Management Disciplines ......................... 195
14.1 Introduction ............................................... 195
14.2 Design Concepts .......................................... 198
14.3 Design Science Research in Organizational Studies .................. 200
14.4 Conclusions ............................................... 204
References .................................................... 205

15 Design Science Research in Information Systems: A Critical Realist Approach ................. 209
15.1 Introduction ............................................... 210
15.2 Why an Alternative Information Systems Design Science Research Approach? ........ 211
15.3 Critical Realism .......................................... 214
15.4 A Critical Realist Approach for IS Design Science Research ........... 217
  15.4.1 For Whom Should IS Design Science Research Produce Knowledge? .... 217
  15.4.2 What Types of IS Design Knowledge Should IS Design Research Produce? .... 218
  15.4.3 Developing IS Design Knowledge ................................ 221
  15.4.4 Examples of How to Develop IS Design Theories and Design Knowledge .... 224
  15.4.5 Design Theory #1: Developing a Design Theory for Turning KMS Use into Profit .... 224
  15.4.6 Design Theory #2: Developing a Design Theory for Successful Use of e-Learning ........ 226
Contents

15.4.7  Design Theory #3: Developing a Design Theory on How to Improve the Capability of IS Integration in M&As ........................................ 227
15.5  Conclusion ................................................................. 229
References ................................................................. 229

16  Design of Emerging Digital Services: A Taxonomy ......................... 235
16.1  Introduction ................................................................. 235
16.2  Service Versus Digital Service ........................................... 237
16.3  Research Objectives ......................................................... 238
16.4  Why Taxonomy? ............................................................... 240
16.5  Grounding of the Taxonomy .............................................. 240
16.6  Fundamental Design Dimensions ......................................... 241
  16.6.1  Service Delivery ....................................................... 242
  16.6.2  Service Maturity ....................................................... 243
  16.6.3  Malleability ............................................................ 244
  16.6.4  Pricing and Funding ................................................... 245
16.7  Fundamental Service Provider Objectives .................................. 247
  16.7.1  Business Objective .................................................... 247
  16.7.2  Technological Objectives ............................................ 248
  16.7.3  Interaction Objectives ................................................. 248
16.8  Summary of the Taxonomy ................................................. 249
16.9  Evaluation of the Taxonomy ............................................... 250
  16.9.1  Salesforce.com ........................................................ 250
  16.9.2  Myspace.com .......................................................... 251
  16.9.3  Itunes.com ............................................................. 251
16.10  Future Research Considerations ......................................... 251
References ................................................................. 252

17  Disseminating Design Science Research ....................................... 255
17.1  Academic Route - Conference and Journal Papers ....................... 255
17.2  Funding to Support Your Design Research ................................ 257
17.3  Commercializing Your Ideas via Start-Ups ................................ 258
References ................................................................. 259

18  Design Science Research: Looking to the Future ............................ 261
18.1  Introduction ................................................................. 261
18.2  Trend 1: Growing Number of IS Scholars Will Use Design as a Research Method .................................................... 262
18.3  Trend 2: Growing Number of Scholars Will Research Design .......... 262
18.4  Trend 3: A Small but Steady Number of Scholars Will Study Design Theory .................................................... 263
18.5  Trend 4: An Uptake Is Expected in These Three IT Application Area Thereby Creating a Surge in the Need for Design Researchers .................................................... 263
  18.5.1  Health Care and IT ................................................... 263
18.5.2 Green Technology and Green IT 264
18.5.3 Green Computing 266
18.5.4 Collaboration, Web 2.0, and Social Technologies 267
References 267

Appendix A: Hevner, March, Park, and Ram 2004 MISQ Reprint 269

Appendix B: Exemplar Publications of Design Science Research in Information Systems 301

Contributors 305

Index 309