

---

# Contents

<b>1</b>	<b>Introduction.....</b>	<b>1</b>
1.1	Design.....	1
1.2	Design Research .....	2
1.3	Main Issues.....	6
1.3.1	Lack of Overview of Existing Research.....	6
1.3.2	Lack of Use of Results in Practice.....	7
1.3.3	Lack of Scientific Rigour .....	8
1.4	Need for a Design Research Methodology.....	9
1.5	Objectives .....	10
1.6	Structure of This Book.....	11
1.7	Main Points.....	12
<b>2</b>	<b>DRM: A Design Research Methodology.....</b>	<b>13</b>
2.1	Introduction.....	13
2.2	Methodological Framework.....	14
2.3	Types of Research Within the DRM Framework .....	18
2.4	Representing Existing and Desired Situations .....	19
2.4.1	Graphical Representation .....	20
2.4.2	From Reference Model to Impact Model .....	24
2.5	Success Criteria and Measureable Success Criteria.....	26
2.6	The Main Stages .....	29
2.6.1	Research Clarification (RC) .....	29
2.6.2	Descriptive Study I (DS-I).....	31
2.6.3	Prescriptive Study (PS).....	33
2.6.4	Descriptive Study II (DS-II).....	35
2.6.5	Summary .....	38
2.7	Comparison with Other Methodologies.....	38
2.8	Main Points.....	41
<b>3</b>	<b>Research Clarification.....</b>	<b>43</b>
3.1	Research Clarification Process .....	44
3.2	Identifying Overall Topic of Interest .....	45
3.3	Clarifying Current Understanding and Expectations .....	51

3.4	Clarifying Criteria, Main Questions and Hypotheses .....	57
3.4.1	Criteria .....	57
3.4.2	Research Questions and Hypotheses .....	59
3.5	Selecting Type of Research .....	60
3.6	Determining Areas of Relevance and Contribution .....	63
3.7	Formulating Overall Research Plan .....	67
3.7.1	Overall Research Plan .....	67
3.7.2	Visualisation Exercise .....	68
3.7.3	Reflection on RC .....	69
3.8	General Guidelines on Doing Research .....	70
3.9	Main Points .....	72
<b>4</b>	<b>Descriptive Study I: Understanding Design .....</b>	<b>75</b>
4.1	Schools of Thought .....	76
4.2	Types of DS-I .....	80
4.3	DS-I Process Steps .....	80
4.4	Reviewing Literature .....	81
4.4.1	Identifying Literature .....	82
4.4.2	Summarising Literature .....	83
4.4.3	Updating Reference and Impact Models .....	86
4.5	Determining Research Focus .....	89
4.5.1	Identifying and Defining Factors and Links of Interest .....	89
4.5.2	Formulating Research Questions and Hypotheses .....	90
4.5.3	Techniques for Refining Research Questions and Hypotheses ....	96
4.5.4	Focusing the Set of Research Questions and Hypotheses .....	101
4.6	Developing Research Plan for DS-I .....	102
4.6.1	Selection of Methods .....	102
4.6.2	Selection of Data-collection Methods .....	103
4.6.3	Detailing the Research Plan .....	109
4.6.4	Pilot Study .....	114
4.7	Undertaking an Empirical Study .....	114
4.7.1	Collecting Data .....	115
4.7.2	Processing Data .....	116
4.7.3	Analysing and Interpreting Data .....	121
4.7.4	Verifying Results .....	124
4.7.5	Drawing Conclusions .....	128
4.7.6	Updating the Initial Reference Model .....	129
4.7.7	Determining Further Empirical Studies .....	130
4.8	Drawing Overall Conclusions .....	131
4.8.1	Combining Results of Empirical Studies .....	131
4.8.2	Completing the Reference Model and Updating the Initial Impact Model .....	132
4.8.3	Documenting Research .....	135
4.8.4	Consequences and Suggestions for the Intended Support .....	136
4.8.5	Determining Next Stage .....	136
4.8.6	Determining Future Work .....	136
4.9	Main Points .....	137

<b>5 Prescriptive Study: Developing Design Support .....</b>	<b>141</b>
5.1 Types of Design Support .....	142
5.2 Types of PS.....	143
5.3 A Systematic PS Process .....	144
5.4 Task Clarification .....	148
5.5 Conceptualisation.....	153
5.5.1 Determining Main Functions.....	153
5.5.2 Generating and Selecting Support Concepts .....	155
5.5.3 Introduction Plan .....	159
5.6 Elaboration.....	164
5.7 Realisation .....	167
5.7.1 Core Contributions, Support Functionalities and Outline Evaluation Plan.....	167
5.7.2 Developing Actual Support .....	169
5.7.3 Actual Introduction Plan and Actual Impact Model.....	171
5.7.4 Tool Development .....	173
5.8 Support Evaluation .....	176
5.9 Main Points.....	178
 <b>6 Descriptive Study II: Evaluating Design Support .....</b>	 <b>181</b>
6.1 Evaluation.....	182
6.1.1 Importance of Evaluation .....	182
6.1.2 Types of Evaluation in DRM.....	184
6.1.3 Synthesis Example.....	186
6.1.4 DS-I Versus DS-II .....	189
6.1.5 Existing Evaluation Approaches.....	190
6.2 Types of DS-II.....	195
6.2.1 Initial DS-II .....	195
6.2.2 Comprehensive DS-II .....	195
6.3 Systematic DS-II Process.....	196
6.4 Reviewing Existing Documentation .....	197
6.5 Determining Evaluation Focus .....	199
6.5.1 Aspects to be Considered .....	199
6.5.2 Determine Focus.....	201
6.6 Developing Evaluation Plan(s) .....	201
6.6.1 Develop Measurements .....	202
6.6.2 Evaluation Plan.....	204
6.6.3 Pilot Study .....	209
6.7 Undertaking Evaluation .....	209
6.8 Drawing Overall Conclusions.....	211
6.9 Main Points.....	212
 <b>7 Writing Up: Publishing Results.....</b>	 <b>215</b>
7.1 Various Forms of Publication and Their Intent.....	216
7.2 Overall Structure of a Thesis .....	217
7.3 Approaches to Help Structure a Thesis.....	219
7.3.1 Table of Content Approach .....	219

7.3.2	Presentation Approach.....	219
7.3.3	Methodical Design Approach.....	220
7.3.4	Question and Answer Approach.....	220
7.4	Tips on Writing Specific Sections .....	221
7.4.1	Writing the Table of Contents and Other Lists.....	221
7.4.2	Writing the Introduction .....	221
7.4.3	Writing the Literature Review .....	222
7.4.4	Writing the Research Approach.....	224
7.4.5	Writing the Outcomes.....	224
7.4.6	Writing the Conclusions and Acknowledgements.....	225
7.4.7	Writing the Reference List and Bibliography.....	226
7.5	Writing Papers .....	227
7.6	General Guidelines .....	227
7.6.1	About Content .....	227
7.6.2	About Form .....	228
7.7	Main Points.....	229
<b>8</b>	<b>Summary and Conclusions .....</b>	<b>231</b>
8.1	Experience of Using DRM .....	231
8.1.1	Feedback from the Summer School on Engineering Design Research .....	233
8.1.2	Feedback from the Design Research Methodology Course.....	235
8.1.3	Other Sources .....	236
8.2	Further Research.....	237
<b>A</b>	<b>Descriptive Study Methods .....</b>	<b>239</b>
A.1	Paradigms and Assumptions .....	239
A.1.1	Paradigms .....	240
A.1.2	Assumptions .....	242
A.2	Reviewing Empirical Studies.....	243
A.2.1	Aim, Research Questions, Hypotheses.....	245
A.2.2	Nature of the Study.....	245
A.2.3	Theoretical Basis .....	245
A.2.4	Unit of Analysis.....	246
A.2.5	Data-collection Method .....	246
A.2.6	Role of Researcher .....	247
A.2.7	Time Constraint.....	248
A.2.8	Continuation .....	248
A.2.9	Duration.....	248
A.2.10	Observed Process .....	248
A.2.11	Setting .....	249
A.2.12	Task.....	249
A.2.13	Number of Cases .....	250
A.2.14	Case Size .....	250
A.2.15	Participants.....	251
A.2.16	Object.....	251
A.2.17	Coding and Analysis Method(s).....	251

A.2.18	Verification Method(s).....	251
A.2.19	Findings.....	252
A.2.20	Notes .....	252
A.2.21	Example.....	252
A.3	Laboratory Versus Industrial Environment.....	254
A.4	Data-collection Methods.....	254
A.4.1	Observation .....	257
A.4.2	Simultaneous Verbalisation .....	262
A.4.3	Experiments, Quasi-experiments and Non-experiments.....	264
A.4.4	Case Study .....	268
A.4.5	Collecting Documents .....	269
A.4.6	Collecting Products .....	269
A.4.7	Questionnaires .....	269
A.4.8	Interviewing.....	271
A.4.9	Action Research.....	273
A.5	Statistical Analysis.....	273
<b>B</b>	<b>Prescriptive Study Methods</b> .....	277
B.1	Product Development Methodologies.....	277
B.1.1	Methods for Analysing Objectives and Establishing Requirements.....	278
B.1.2	Methods for Synthesising Support Proposals .....	279
B.1.3	Methods for Simulating Support Behaviour.....	280
B.1.4	Methods for Evaluating and Selecting Support Proposals.....	281
B.2	Software Development Approaches.....	282
B.2.1	A Design Support Software Development Methodology .....	282
B.2.2	Software Development Paradigms .....	283
B.2.3	Generic Software Development Methodologies .....	285
B.2.4	The Waterfall Model .....	286
B.2.5	Generic Technologies .....	290
B.2.6	CASE Tools.....	294
B.3	User-interface Design .....	295
B.3.1	User-interface Development Issues .....	295
B.3.2	Levels of Abstraction.....	297
B.3.3	User-interface Development Processes and Methods.....	297
B.3.4	Interactive Software Development Environments .....	300
B.3.5	User-interface Evaluation .....	300
B.4	Support Outline: Summarising Scope and Assumptions .....	301
<b>C</b>	<b>Example Research Projects</b> .....	305
C.1	Overview of the Examples.....	305
C.2	A Process-based Approach to Computer-supported Engineering Design.....	307
C.2.1	Introduction and Aim of Research.....	307
C.2.2	Research Approach.....	308
C.2.3	Results .....	311
C.2.4	Evaluation of the Results .....	314

C.2.5	Conclusions About the Research Approach .....	316
C.2.6	Continuation .....	316
C.2.7	References .....	316
C.2.8	Reflections from the DRM Perspective .....	316
C.3	A Program for Computational Synthesis and Conceptual Design Support.....	318
C.3.1	Introduction and Aim of Research.....	318
C.3.2	Research Approach.....	319
C.3.3	Results .....	322
C.3.4	Evaluation of Results.....	324
C.3.5	Conclusions About the Research Approach .....	325
C.3.6	Continuation .....	325
C.3.7	References .....	326
C.3.8	Reflections from the DRM Perspective .....	326
C.4	Teamwork in Engineering Design .....	328
C.4.1	Introduction and Aim of Research.....	328
C.4.2	Research Approach.....	329
C.4.3	Results .....	334
C.4.4	Evaluation of Results.....	336
C.4.5	Conclusions About the Research Approach .....	336
C.4.6	Continuation .....	337
C.4.7	References .....	337
C.4.8	Reflections from the DRM Perspective .....	338
C.5	Measuring Conceptual Design Process Performance in Mechanical Engineering: A Question-based Approach .....	339
C.5.1	Introduction and Aim of Research.....	339
C.5.2	Research Approach.....	340
C.5.3	Results and Evaluation of Results .....	344
C.5.4	Conclusions About the Research Approach .....	348
C.5.5	Continuation .....	349
C.5.6	References .....	349
C.5.7	Reflections from the DRM Perspective .....	350
C.6	Design for Quality .....	351
C.6.1	Introduction and Aim of Research.....	351
C.6.2	Research Approach.....	353
C.6.3	Results .....	355
C.6.4	Evaluation of Results.....	358
C.6.5	Conclusions About the Research Approach .....	359
C.6.6	Continuation .....	359
C.6.7	References .....	359
C.6.8	Reflections from the DRM Perspective .....	360
C.7	Multi-disciplinary Design Problems .....	361
C.7.1	Introduction and Aims of the Research .....	361
C.7.2	Research Approach.....	363
C.7.3	Results and their Evaluation .....	366
C.7.4	Conclusions About the Research Approach .....	368
C.7.5	Continuation of Project.....	368

C.7.6	References .....	369
C.7.7	Reflections from the DRM Perspective .....	370
C.8	Design for Reliability in Mechanical System .....	371
C.8.1	Introduction and Aim of Research .....	371
C.8.2	Research Approach .....	372
C.8.3	Results .....	376
C.8.4	Evaluation of the Results .....	378
C.8.5	Conclusions About the Research Approach .....	379
C.8.6	Continuation .....	380
C.8.7	References .....	380
C.8.8	Reflections from the DRM Perspective .....	380
<b>References .....</b>		<b>383</b>
<b>Index .....</b>		<b>393</b>



<http://www.springer.com/978-1-84882-586-4>

DRM, a Design Research Methodology

Blessing, L.T.M.; Chakrabarti, A.

2009, XVII, 397 p., Hardcover

ISBN: 978-1-84882-586-4