

Contents

1	Introduction: the architectural design process	1
1.1	Motivations	3
1.2	Background	4
	1.2.1 Empirical accounts of design	4
	1.2.2 Theoretical accounts of design	5
	1.2.3 Design instruction	6
1.3	Contents	7
	1.3.1 What is included?	7
	1.3.2 What is not included?	8
	1.3.3 Intended audience	9
	1.3.4 Method of investigation	9
	1.3.5 Outline of book	10
1.4	Suggested readings	11
2	Theory of information processing	12
2.1	Codifying human problem-solving	13
	2.1.1 State space representations	14
	2.1.2 State transformations	15
	2.1.3 Reaching the goal state	16
2.2	Architecture of the human memory	17
2.3	Design and problem-solving	19
2.4	Design versus problem-solving	20
2.5	Summary	22
2.6	Suggested readings	22
2.7	Exercises	22
3	Studying complex process	24
3.1	Systems, behavior, and internal mechanisms	25
3.2	An example of architectural design	28
3.3	Architectural design knowledge	32
	3.3.1 Procedural versus declarative knowledge	32
	3.3.2 Specific versus general knowledge	33
3.4	Analysis of design protocols	36
3.5	State transformations in architectural design	48
3.6	Knowledge and behavior in design	51
3.7	Summary	52
3.8	Suggested readings	53
3.9	Exercises	53
4	An information-processing model of design	55
4.1	Architecture of an information-processing system for design: DIPS	56
4.2	External representations in design	58
	4.2.1 External memory (EM)	61

4.3	Design processes	63
	4.3.1 Acquisition of information	64
	4.3.2 Representation of information	68
	4.3.3 Transformation processes in design	71
4.4	Process sequences	80
4.5	Suggested readings	82
4.6	Exercises	83
5	Search in design	84
5.1	Codifying the design process	84
	5.1.1 Codifying the designer's focus of attention	86
	5.1.2 Codifying the primitive design processes	88
5.2	Global search methods	90
	5.2.1 Depth-first search	90
	5.2.2 Breadth-first search	92
	5.2.3 Satisficing solutions	93
5.3	Local search methods	97
	5.3.1 Generate-and-test (GAT)	98
	5.3.2 Hill-climbing (HC)	100
	5.3.3 Heuristic search (means-end-analysis, MEA)	101
	5.3.4 Induction	108
	5.3.5 Accounting for design behavior	110
5.4	Synopsis	110
5.5	Suggested readings	111
5.6	Exercises	111
6	Representation in design	112
6.1	Representations of design in memory	113
	6.1.1 Productions	113
	6.1.2 Conceptual inference structures	115
	6.1.3 Chunks	117
	6.1.4 Logistics of memory organization	118
6.2	Representation of architectural drawings	119
	6.2.1 Experiment 1: chunking	119
	6.2.2 Experimental design	120
	6.2.3 Chunks in architectural drawings	122
	6.2.4 Structure of architectural elements	124
	6.2.5 Interchunk structures	126
6.3	Representation of inferential knowledge	130
	6.3.1 Experiment 2: building puzzle	131
	6.3.2 Rewriting rules	133
	6.3.3 Rewriting rules and inductive reasoning in design	136
	6.3.4 Learning and rewriting rules	137
6.4	Suggested readings	138
6.5	Exercises	138

Contents

7	Inductive reasoning in architecture	140
7.1	Inductive reasoning with computers	141
7.2	Codifying human reasoning	142
	7.2.1 Experimental design	143
	7.2.2 Knowledge used in the task domain	145
7.3	An architecture for machine reasoning: AIM	146
	7.3.1 The working memory space	146
	7.3.2 Rewriting rule space (RRS)	148
	7.3.3 Heuristic rule space (HSR)	150
	7.3.4 Runs of AIM	155
7.4	Evaluation of AIM	156
7.5	Human versus machine reasoning	160
7.6	AIM as an experimental tool	162
7.7	Summary	163
7.8	Suggested readings	164
7.9	Exercises	164
8	Summary: modelling the design process	165
8.1	Calibration of the model	165
	8.1.1 Search	165
	8.1.2 Representation	166
	8.1.3 Reasoning	167
	8.1.4 Research objectives	167
	8.1.5 Understanding the design process	168
	8.1.6 New research areas	169
	8.1.7 Developing and interfacing design aids	170
	8.1.8 Teaching of design	171
9	Epilogue: a position on design	172
9.1	Description of the design process	173
9.2	Finite nature of architectural knowledge	174
9.3	Tools of problem-solving in design	175
9.4	Teaching design	176
9.5	Final thoughts	179
Appendix A.1		181
Appendix A.2		183
A.2.1	Generate-and-test	183
A.2.2	Hill-climbing	184
A.2.3	Heuristic search (means - end)	184
A.2.4	Induction	184