Contents

L		•	Chapter. Contemporary Chantenges	
	of In	novatio	n	1
	1.1	Introdu	action: Training for Design Today	1
	1.2	A Few	Puzzles and Paradoxes	5
		1.2.1	The Paradox of R&D: Investment Does not Mean	
			Innovation—Design is Increasingly Difficult	
			to Organize	5
		1.2.2	Paradoxes in the Organization of Innovative Design	7
		1.2.3	Paradoxes of Reasoning in Innovative Design	8
	1.3	The Is:	sue of Definitions: Capacity for Innovation	
		and De	esign Regimes	9
		1.3.1	Traps in the Term "Innovation"	9
		1.3.2	The Notion of Design Regime	10
	1.4	Canon	ical Model for a Design Regime	11
		1.4.1	Canonical Model of Reasoning X, K(X),	
			$D(X), P(X) \dots$	11
		1.4.2	Canonical Model of Performance	14
		1.4.3	Canonical Model of Organization	15
	1.5	Conclu	sion	16
		1.5.1	Main Ideas of the Chapter	16
		1.5.2	Additional Reading	16
	Refer	ences		17
2	Desig	ning in	a Rule-Based Regime—Systematic Design	
	Theo		Project Management	19
	2.1	Reason	ning in Systematic Design	19
		2.1.1	Expectations of Systematic Theory	20
		2.1.2	Fundamental Principles	20
		2.13	Illustrative Examples of Language	23

		Conten	LS

x

3

	2.1.4 2.1.5	Tools and Associated Techniques Contemporary Trends in Rule-Based Design	25 28
2.2	Perform	nance in Systematic Design	32
	2.2.1	Fundamental Principle: Maximizing the Re-use	
		of Knowledge	32
	2.2.2	Practical Assessment	33
2.3		zation of the Systematic Design Project	39
2.5	2.3.1	General Principles: Project and Project Leader	39
	2.3.2	Division of Labor in Systematic Design: Stage-Gate	
		Process and "V" Cycle	40
	2.3.3	Project Leader's Management Tools: Planning,	
	2.0.0	PERT Charts and Budget Reporting	41
2.4	Conclu	sion	42
2.,	2.4.1	Main Ideas of the Chapter	44
	2.4.2	Additional Reading	44
2.5	. –	hop 2.1: Functional Analysis	45
2.6		tudy 2.1: The Logic Underlying the Domestication	
2.0		ign: The Origin and Success of Systematic Design	49
	2.6.1	Wild Design: The Inventor-Entrepreneurs	••
	2.0.1	of the First Industrial Revolution in England	49
	2.6.2	Parametric Rule-Based Design: "Recipe-Based"	72
	4,0,2	Design or Pathways for Industrial "Catch-Up"	50
	2.6.3	Systematic Rule-Based Design: The Invention	50
	2.0.5	of the Engineering Department	55
Dafor	ences		59
		•••••••••••••••••••••••••••••••••••••••	29
Desig	ming the	Rules for Rule-Based Design-Conceptual and	
Gene	rative N	Iodels, Axiomatic Design Theory	63
3.1	The Lo	ogic of Performance in Systematic Design—The Notion	
	of Don	ninant Design	63
	3.1.1	A Few Examples of Sector-Wise Performance	64
	3.1.2	Characterizing the Performance	
		of Systematic Design	65
	3.1.3	The Notion of Dominant Design	67
3.2	The Lo	gic of Reasoning in Systematic Design: Conceptual	
	and Ge	nerative Models—Axiomatic Design Theory	67
	3.2.1	Conceptual and Generative Models.	67
	3.2.2	Assessing Systems of Rules: Axiomatic	٠.
		Design Theory	74
		•	, 4

Contents xi

	3.3	The U	rganizations of Systematic Design	83
		3.3.1	Skill-Sets and Guarantors of the Company's Rule Base	83
		3.3.2	Sector-Wise Industrial Organization—The Ecosystems	
			of Rule-Based Design	85
		3.3.3	The Logic of Generative Bureaucracies—Coordination	
			and Cohesion	86
	3.4	Conclu	ssion: Routine/Generative Equilibrium	87
		3.4.1	The Main Ideas of this Chapter	88
		3.4.2	Additional Reading	88
	3.5	Works	hop 3.1: Calculation of Static and Dynamic	
		Return	s on Platform	89
		3.5.1	Introduction: Design Function, Static and Dynamic	
			Returns	89
		3.5.2	Platform-Based Project Evaluation	90
	3.6	Works	hop 3.2: Design by Use—The Usefulness	
		of Con	ceptual Models	93
	3.7	Case S	Study 3.1: The Origins of Industrial Research	97
		3.7.1	A Brief History of the First Company Research	
			Laboratories	97
		3.7.2	Questions that Would Stimulate the Emergence	
			of Industrial Research	98
		3.7.3	Rationalization of Industrial Research: Rationalizing	
			the Process of Knowledge Production	101
		3.7.4	The Origins of the Myth of Innovative Research: Nylon	106
	3.8	Case S	study 3.2: Emergence and Structuring of the Acoustics	
		Occupa	ation in Automobile Engineering—Effectiveness	
		of Con	ceptual Models (Jean-Hervé Poisson, Renault)	111
		3.8.1	1964-1970: The Birth of the Acoustics	
			Department—First Conceptual Models	112
		3.8.2	1970-1979: Structure of the Profession—Complex	
			Conceptual Models	113
		3.8.3	1979-1998: The Era of Fine Tuning	115
		3.8.4	1998-2005: Rejuvenating the Profession—New	
			Conceptual Models	117
	Refer	ences		121
1	Docio	nina in	an Innovative Design Regime-Introduction	
•			n Theory	125
	4.1		ning in Innovative Design—C-K Theory	125
	4.1	4.1.1	Origins and Expectations of C-K Theory	126
		4.1.1	Main Notions: Concepts, Knowledge and Operators	129
		4.1.3	Main Properties	135
		4.1.3	C-K Theory and Other Theories of Design.	140
		4.1.4	Why C-K Theory Meets Our Initial Expectations	140
		4.1.3	why C-ix Theory incers our initial expectations	145

		Contents

хii

5

4.2	Perfori	mance of the Innovative Design Project	150
	4.2.1	Fundamental Principle of Performance in Innovative	
		Design: Giving Value to Expansions	150
	4.2.2	Outputs: V2OR Assessment	151
	4.2.3	Inputs: Estimation of the Resources Consumed	
		in the Case of an Isolated Innovative Project	155
	4.2.4	The Logic of Input/Output Coupling	155
4.3	Organi	ization of an Innovative Design Project	157
	4.3.1	Design Space and Value Management	157
	4.3.2	New Principles of Cohesion: Strategy and Commitment	161
4.4	Conob	usion	162
4.4	4.4.1	Main Ideas of the Chapter	163
	4.4.1	Additional Reading	163
4.5		Study 4.1: Mg-CO ₂ Motor	165
4.3	4.5.1	Before C-K Work	165
	4.5.1	C-K Reasoning in the Endeavor	166
4.6		Shop 4.1: Intensive Innovation and the Identity	100
4.0		ects—Analysis Tools	169
	4.6.1	Acceleration of Rule-Based Innovation.	169
	4.6.2	Analyzing Objects' Disruption of Identity	169
	4.6.3	Generalized and Repeated Disruptions	171
4.7		Shop 4.2: Smart Shopping Cart and Other Exercises	175
4.7	4.7.1	Use of the Theory on a Brief	175
	4.7.1	Simple C-K Exercises	175
4.8		Study 4.2: Ideo	179
4.0	4.8.1	Process Description and Analysis	179
	4.8.2	Process Evaluation	
Dat			181
KC.	iciciices .	••••••	183
Des	signing th	e Innovative Design Regime—C-K Based	
Or	ganizatior	18	187
5.1	Perform	mance in Innovative Design	187
	5.1.1	Outputs: Sustainable Revision of Object Identity	188
	5.1.2		190
	5.1.3	Performance: The New Industrial Dynamic	192
5.2	Reason	ning and Tools	195
	5.2.1	Issue: Collective De-fixation	195
	5.2.2	The Structure of C and K-Spaces Conducive to	
		Innovative Design	199
	5.2.3	Strategies	211
	5.2.4	Tools and Processes—KCP, C-K-Invent,	
		C-K References Method	218
5.3	Organi	ization	231
The state of the s			

Contents xiii

	5.3.1	From R&D Organization to RID	232			
	5.3.2	R _c and D _c : The New Players in the Processes				
		of Innovative Design	237			
	5.3.3	Colleges and Architects of the Unknown:				
		New Designers Outside the Firm	249			
5.4	Conclu	sion: a new governance for innovation	262			
	5.4.1	The Main Ideas of this Chapter	263			
	5.4.2	Additional Reading	264			
5.5	Works	hop 5.1: The KCP Method	265			
	5.5.1	Phase K: Forming a Common K Base with				
		a Strong Partitioning Power	265			
	5.5.2	Phase C: Shedding Light on Paths in the Dark				
		Thanks to "Projectors"	271			
	5.5.3	Phase P: Developing a Design Strategy	278			
5.6	Case S	tudy 5.1: Edison, from Inventive Genius to Creator				
		nnovative Firm: Edison's Invention Factory	291			
	5.6.1	Why Edison?	291			
	5.6.2	Some Elements to Evaluate Innovative Design				
		Performance	292			
	5.6.3	What Reasoning and Design Methods Were Used				
		by Edison?	293			
	5.6.4	Organization of the Invention Factory	298			
5.7	Case S	tudy 5.2: Organization of the Innovative Design				
		les Avionics (Author: Denis Bonnet)	303			
	5.7.1	Origins	303			
	5.7.2	Global Approach	304			
	5.7.3	The Innovative Design Process	305			
	5.7.4	Demonstrators and Prototypes	305			
	5.7.5	The Work Space—Innovation Hub.	306			
	5.7.6	The Process of "Regulating" Design (TRL 4-5)	306			
5.8	•	tudy 5.3: Conceptive Research for Conceptual	500			
2.0	Absorptive Capacity: The Non-CMOS Image Sensors					
		Microelectronics	309			
5.9	•	tudy 5.4: Building with Hemp,—Taming Technological	502			
J.)		s by Managing Generative Expectations	313			
	5.9.1	Contrasting Two Models of Expectations Management:	51.			
	3.7.1	Anticipative Expectations Management Versus				
		Generative Expectations Management	313			
	5.9.2	Some Elements on the Research Method	317			
	5.9.2	Smart Expectation Management in "Building	217			
	3.7.3		318			
	5.9.4	with Hemp" Main Results and Implications				
Defa-	J.Y.4	Main Results and Implications	326			

xiv		Contents

Appendix: Past Examination Questions in the Course 'Product Design and Innovation' at MINES, ParisTech (2004–2011)	337
Appendix A: Knowledge Control 2004—Product Design and Innovation	339
Appendix B: Knowledge Control 2005—Product Design and Innovation	341
Appendix C: Knowledge Control 2006—Product Design and Innovation	343
Appendix D: Knowledge Control 2007—Product Design and Innovation	345
Appendix E: Knowledge Control 2008—Product Design and Innovation	351
Appendix F: Knowledge Control 2009—Product Design and Innovation	357
Appendix G: Knowledge Control 2010—Product Design and Innovation	363
Appendix H: Knowledge Control 2011—Product Design and Innovation	369
Index of Cited Authors	373
Index of Companies, Organisations and Products	379
Index of Notions	381